THE ANNALS
AND
MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

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

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

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

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

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

J. Taylor, *Norwich*, 1818.

ALERE FLAMMAM.

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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH 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. 61. JANUARY 1893.

I.—*On some Points in the Morphology of the Arachnida (s. s.), with Notes on the Classification of the Group.* By R. I. Pocock, of the British Museum (Natural History).

[Plates I. & II.]

Since it is generally admitted that the ancestor or ancestors of the Arthropoda must be sought for in animals resembling the Annelidan worms in the complete segmentation of the body, it seems clear that a species in which the metamerism is highly developed is, *cæteris paribus*, more primitive than an allied form in which it is obscurely manifested. The two common decapod crustaceans, the crab and the lobster, furnish a good example of the truth of this maxim, the latter animal with its gangliated nerve-chord, its long, segmented, and limb-bearing abdomen, being unquestionably more nearly related to the primitive form or ancestor of the Decapoda than the crab. Consequently in tracing the phylogeny of this group of crustaceans we should conclude that the Brachyura are the descendants of the Macrura, and that as such they should occupy a higher branch of a genealogical tree.

The truth of this, however, is so very obvious that the only excuse to be offered for its restatement is the circumstance that not all authors have borne it in mind in dealing with the phylogeny of the Arachnida. This at least seems to be borne out by the phylogenetic tree of this group that was published by Dr. Thorell in 1877 *. From this tree it appears that the Scorpions branch off from the Pedipalpi, the latter from the Araneæ, the Araneæ from the Opiliones, &c., almost the lowest branch of the Arachnid trunk being assigned to the Acari.

Perhaps, so far as complexity of structure is concerned, a Scorpion stands higher than a sheep-tick, so, no doubt, does an active free-swimming lobster rank above a sluggish Maioid crab. Nevertheless no one would probably on these grounds place the Maiidæ in a phylogenetic tree at a lower level than the Astacidæ. But the reasons that lead us to consider the Macrura nearer than the Brachyura to the ancestor of the Decapoda point also to the conclusion that of all Arachnids the Scorpions most resemble the primitive type; for in these animals the metamerism of the body is more fully expressed than in any other order of Arachnida, all the twelve somites of the abdomen being well developed with dorsal and ventral representatives, the anterior six of them bearing permanent or transitory appendages; furthermore, the nerve-chord is furnished with a series of ganglia and the heart is divided into a greater number of chambers.

Considering, then, on these grounds the primitiveness of the Scorpion's structure, we may imagine that the immediate ancestor of all the Arachnida was constructed somewhat as follows †:—The body was composed of eighteen somites, the anterior six of which were provided with large appendages set apart for locomotion and the prehension and mastication of food; the terga of this cephalothoracic region were fused to form a single shield or carapace, supporting a submedian and a cluster of lateral eyes on each side, and the ventral surface of the carapace, at least in its posterior half, was protected by a sternal plate. Each of the succeeding six somites bore a pair of small ventral appendages, and the generative aperture opened upon the sternal area of the first of these somites. The posterior six somites had lost their appendages, were probably narrower than the rest, and constituted a limbless caudal termination to the body, the last of them being furnished with a single plate, articulated above the anal aperture.

The Scorpions have departed from this hypothetical type in the following particulars:—The otherwise useless posterior

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* Actes Soc. Ital. Sci. Nat. xix. p. 86.

† *Cf.* in this connexion Prof. Lankester's definition of the class Arachnida in Quart. Journ. Micr. Sci. xxi. p. 647 (1881).

five somites are converted into the so-called tail; the posterior four pairs of appendages of the abdominal region have disappeared in connexion with the development of the lung-books, the second pair become the tactile sexual organs or pectines, and the first in all probability constitute the genital operculum *. Moreover the generative aperture has moved forwards between the coxæ of the last pair of cephalothoracic limbs, and the enlargement and ingrowth of the coxæ of this region have more or less obliterated the sternum.

The Arachnida which structurally come nearest the Scorpions are the Pedipalpi. There are three existing very distinct types of this order, *Thelyphonus*, *Schizonotus* †, and *Phrynus*; the first-named being the most Scorpion-like of the three may advantageously be considered first. Great, however, as is the superficial likeness between this genus and a Scorpion, the differences are in reality very considerable. In the first place the whole abdomen is immensely reduced in length by the shortening of the somites along the longitudinal axis, the three posterior alone being abruptly narrowed to constitute a small tail-like support for the filiform multiarticulated telson; in the second place a deep constriction separates the cephalothorax from the abdomen. But more important than all this is the disappearance of the two posterior lung-sacs and the obliteration of the sternite and appendages of the second abdominal somite by the enlargement and backward extension of the sternite of the first, behind which the generative organ opens. Moreover this first sternite, in addition to obliterating the second, encroaches largely upon the third and fourth, reducing them to narrow chitinous bands, the result being that the pulmonary sacs that are situated in the third and fourth somites open in front of their sterna, or, as it is usually expressed, behind the first and second sterna ‡.

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* I am not aware that the evidence of the appendicular nature of the genital operculum is absolutely conclusive.

† A name proposed by Thorell to replace *Nyctalops* of Cambridge, which was preoccupied.

‡ This at least seems to me to be the probable nature and extent of the changes that have affected this region and these parts of the body. I do not see otherwise how to account for the anomalous position of the aperture of the pulmonary sacs behind the first and second sternites, when these sacs belong to the third and fourth somites.

If this view and the one expressed below as to the derivation of the Araneæ from the Pedipalpi is correct, it seems that the two abdominal sternites of the spider *Liphistius* and the opercula of the lung-sacs of the Mygalomorphæ are the homologues of the first and second sterna of the Pedipalpi. In this case the anterior lung-sacs belong to the somite that is represented by the second sternite in *Liphistius* and by the second pair of

Schizonotus presents a strong general likeness to *Thelyphonus* in the form of the body, structure of limbs, &c. The telson, however, consists of a single short segment, and the carapace being rather shorter, has left a larger space between its hinder border and the first abdominal tergite; but this area, otherwise unprotected, is covered by a single or a paired sclerite, which may be either a special development or one of the original cephalothoracic tergites. In any case the result of this segmentation of the carapace is the power to flex the two posterior somites in a vertical plane, the joint being situated between the fourth and fifth appendages. There appears usually to be a single pair of respiratory stigmata situated behind the first sternite, as in *Thelyphonus*. The posterior pair that are developed in *Thelyphonus* appear to be functionless, but upon the third, fourth, and fifth sterna (morphologically the fourth, fifth, and sixth) close to the posterior margin and behind the muscular impressions a pair of dusky patches are visible. These appear to be some internal organs seen through the semitransparent cuticle, and I believe they are the homologues of the three posterior pair of lung-sacs of the Scorpion *. In one species described by Dr. Thorell—*S. Cambridgii*—two eyes are present; but most interesting of all is the disappearance of the respiratory stigmata and the fusion † of the first two sterna of the abdomen, which leaves only ten for this region. This species is of interest in connexion with the possible derivation of the *Solifugæ* from this group.

The third group of Pedipalpi—the Phrynidæ—are of interest inasmuch as in all the characters that they depart from the Thelyphonidæ they approach the true Spiders or Araneæ. The whole body is very much shorter than in the

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opercula in the Mygalomorphæ, while the posterior lung-sacs belong to a somite which has no free sternite. This view is entirely opposed to Macleod's hypothesis respecting the derivation of the lung-books of the spiders.

* These structures have not, I believe, been previously noticed, but they are certainly visible in both the specimens of this genus that I have seen. For affording me an opportunity to examine these examples I am indebted to the kindness of the Rev. O. P. Cambridge, who with great liberality sent to me the types of the two species he has described. That named *tenuicaudata* is referable to the so-called genus *Tripeltis* of Thorell, having the posterior cephalothoracic tergite paired.

† Dr. Thorell's words describing this feature are " . . . *nec limitem inter scuta ventralia* 1*m et* 2*m*, *nec spiracula certo discernere potui*" (Ann. Mus. Genov. xxvii. p. 560, 1889). This author ascribes only eleven terga to the abdomen. I cannot but think, however, that he overlooked the first small tergite, which is present in the two specimens seen by me.

Thelyphonidæ and wider. The telson has disappeared. The shortness of the abdomen is brought about by the reduction in size of the three posterior somites, the terga and sterna being represented by very short, closely approximated, transverse sclerites. Moreover the anterior two tergites are also much smaller than in *Thelyphonus*. The increase in the width of the cephalothorax is accompanied by a recession of the coxæ, especially of the fourth and fifth appendages, from the middle line, leaving a membranous space between the anterior and posterior sternal pieces; this membrane is chitinized from distinct centres. Furthermore, the coxæ of the second pair of appendages are freely movable, and not fused, as in *Thelyphonus*.

The Araneæ or Spiders agree with the Phrynidæ in having a distinct constriction between the cephalothorax and abdomen, in having the coxæ arranged radially round the sternum, those of the second pair being freely movable as maxillæ; in having two-jointed mandibles and normally eight (median and lateral) eyes. Moreover in lower forms there are two pairs of lung-sacs, as in *Phrynus*. Again, although a marked difference between the two groups is the absence of segmentation in the adult Spiders, yet it is interesting to note that during their embryonic condition the ventral surface of the abdomen seems at one time or another to be divisible into eleven sternal areas, as in the adult *Phrynus*. The first of these is apodous and represents probably, I think, the genital sternite; the second, third, fourth, and fifth bear a pair of appendages each, while the last six are without appendages, as in the Scorpion. The anterior two pairs of appendages disappear in connexion with the formation of the breathing-organs; the fate of the posterior two, however, is quite unlike anything met with elsewhere in the Arachnida, for they take on the form of dwarfed limbs and constitute the spinning-mammillæ, which, with their appropriate glands, are the most characteristic features of this group. Their presence constitutes the greatest structural break between the Spiders and Pedipalpi. In the higher forms of Spiders the posterior lung-sacs are replaced by tracheal tubes. In the lowest, i. e. *Liphistius*, the upper surface of the abdomen is furnished with a series of nine tergites, the posterior of which are very much reduced in size, as in *Phrynus*, and the spinning-appendages retain their primitive position close behind the lung-sacs.

Another order of the Arachnida, namely the Pseudoscorpiones, also seems to me to be tolerably nearly related to the Pedipalpi. It is not unusual to associate this group with the Scorpions, as Mr. Cambridge has done in his article in the 'Encyclopædia Britannica;' but it is difficult to find grounds to justify this classification.

In the form of the cephalothoracic appendages, especially of the second pair, there is certainly a close similarity between the Scorpions and the Pseudoscorpiones; but in the structure of the abdomen the difference between the two groups is very great. But the same cannot be said of the abdomen of the Pedipalpi and the animals now under discussion; for the two groups resemble each other in the absence of the pectines and in the presence of only two pairs of respiratory stigmata. Moreover, in such a form as *Garypus litoralis* the same number of somites can be made out in the abdomen as are seen in this region in the Pedipalpi, namely twelve. Furthermore, there is the same inequality in the number between the tergites and sternites, the former being one in excess of the latter *. From the posterior somite forwards the dorsal and ventral sclerites correspond plate for plate until the third tergite and second sternite are reached. Here the correspondence ceases, there being but a single genital sternite for the first and second tergites, exactly as in the Pedipalpi. The stigmata are situated in the third and fourth abdominal somites, but they have taken up a more lateral position than in the Pedipalpi.

In some other forms of this group one of the tergites has disappeared, so that the abdomen is described by systematists as being furnished with only ten of these plates. Moreover the sterna similarly may be reduced to nine.

So far as the embryological history of these animals is concerned, it is especially interesting to note the presence of four pairs of provisional appendages attached to four of the anterior segments of the abdomen. In the absence of evidence to the contrary it seems justifiable to conclude that these appendages are the exact homologues of the four pairs seen in the Araneæ, a group which we have seen to be apparently nearly related to the Pedipalpi.

The next group to be considered is the Opiliones. The animals of this order agree with the Pseudoscorpiones in the tracheal nature of their respiratory organs and in the absence of a "waist" between the cephalothorax and abdomen. This last feature has led to very remarkable results in the forward migration of the generative aperture between the coxæ of the posterior limbs, in some forms even to a position just behind

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* The last somite has not, so far as I am aware, been previously recognized as such. It is, except in distended specimens, almost entirely concealed inside what is apparently the last, namely the eleventh, but which is in reality the last but one.

the mouth. This procession of the abdominal sternites is accompanied by the obliteration of the anterior pair of tracheal stigmata with the sternite that supported them. The remaining stigmata are situated on the first free sternite, and their presence fixes this plate as belonging morphologically to the fourth somite *. Since, however, there is an immense range in structure within the Opiliones, especially touching the number and distinctness of the segments of the abdomen, it is not always easy to compare the somites with those of the Pedipalpi or Chelonethi.

In *Stylocellus*, however, a genus in which the segmentation of the abdomen is well developed, there are nine distinct tergites and eight sternites, and since the presence of the stigmata on the first sternite points to it morphologically as the fourth, we have almost the full complement of somites from the fourth backwards. Moreover, between the last tergite and sternite there is a single anal sclerite which may represent the twelfth tergite. The first free tergite has no free sternite to correspond to it; it appears to belong morphologically to the third somite, since it immediately precedes the tergite that covers the sternite upon which the tracheal organs open. In this case the dorsal elements of the first two somites have disappeared, and on the ventral side the first three sternites appear to be represented in a general way by that part of the intercoxal area of the cephalothorax which lies behind the generative aperture.

In most forms of Opiliones, however, the segmentation of the body is less well expressed than in *Stylocellus*. This genus appears in this respect, as well as in the small number of supernumerary maxillary sclerites, to be one of the most primitive of the order. In the higher forms the abdomen is much more reduced in length, and even when distinct tergites and sternites are strongly developed, as in *e. g.* the *Laniatores*, their number may fall as low as five; while in others, such as *Phalangium*, the segmentation is represented merely by folds of the integument, the tergal and sternal plates being undeveloped. This reduction in the number of the dorsal and ventral plates is brought about by their fusion with each other or with the cephalothorax.

That the Acari are nearly related to the Opiliones seems evident from a comparison between the two orders. For, as Dr. Thorell says, "from the Acari the Opiliones are scarcely in all cases distinguishable by any other external character than the structure of the abdomen, which, in the Opiliones, is

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* If the third, it is not easy to explain the disappearance of the second pair of stigmata.

evidently segmented at least at its posterior end" [*]. Some of the free-living Acari, *e. g.* the Trombidiidæ and Holothyridæ, with their pediform, claw-tipped palpi and chelate mandibles, bear so strong a resemblance to *Stylocellus*, that with an example of this genus in hand it is impossible not to think that the Acari are descended from the Opiliones [†].

As for the Solifugæ, their position is not so clear. They seem to show affinities with the Pedipalpi through the Tartarides (Schizonotidæ) and also with the Pseudoscorpiones, as Simon long ago suggested [‡].

In the first place the carapace, instead of consisting of a single shield, is usually described as being divided into three distinct sclerites, the posterior two of which are regarded as the tergites of the posterior two somites of the cephalothorax.

The rest of the body, the abdomen, consists of only ten somites, the tergites and sternites apparently corresponding exactly in the first nine, while the last is a single plate perforated mesially by a vertical slit—the anus. The generative aperture is, as usual, situated upon the ventral surface of the first, while the second and third bear the apertures of the tracheal breathing-organs.

It is thus clear that these Arachnida fall into the same section as the Pedipalpi, Araneæ, Pseudoscorpiones, Opiliones, and Acari, inasmuch as they are all devoid of the pectines which are so characteristic of the Scorpions. So, too, does it seem likely that the first sternite corresponds to that of the Pedipalpi, Araneæ, &c., in which case it will represent, according to our theory, the first enlarged abdominal sternite of the Scorpion. Then the two following sternites bearing the apertures of the breathing-organs will belong to the third and fourth somites respectively, and the breathing-organs will correspond in number and position with those of the Pedipalpi and Pseudoscorpiones. In this case one of the somites has disappeared behind the fourth. In all probability the missing one is the twelfth, and we can imagine that it has vanished from view inside the eleventh, almost exactly as in the Pseudoscorpiones. Then the eleventh somite will resemble that of the last-named group in consisting of a single plate,

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[*] Bih. Sv. Vet.-Akad. Handl. xvii. no. 9, p. 8 (1892).

[†] In an interesting paper, recently published in vol. xxiv. of the Journ. Linn. Soc., Zoology, my friend Mr. H. M. Bernard has advanced reasons for showing that the Acari are derived from the Spiders. Without now venturing to discuss in detail the views put forward in this paper, I will merely say that in my opinion the conclusion arrived at would have been nearer the truth if the word "Opilionid" had been substituted all through for "Araneid."

[‡] 'Les Arachnides de France,' vii. pp. 9, 10 (1879).

which results from the fusion of the tergite and sternite. The other missing tergite is, I suspect, the first.

Concerning the Palpigradi, an order established by Thorell for the genus *Kœnenia* of Grassi, I can say very little, never having had the good fortune to examine a specimen of this group. This curious form seems to lie somewhere between the Pedipalpi, especially the Schizonotidæ, and the Solifugæ. As in the last the abdomen is said to consist of ten segments, but the last three are narrowed to support an antenniform telson as in *Thelyphonus.* Moreover, the cephalothorax appears to be segmented very much as in the Solifugæ and Schizonotidæ. Unfortunately nothing is known of the breathing-organs of *Kœnenia,* except their reputed absence; so it is impossible to speculate further as to the true affinities of this genus.

Respecting *Gibbocellum,* the systematic position of which is a matter of debate, I can suggest nothing new. It is no doubt referable either to the Opiliones or Pseudoscorpiones, and probably to the former.

So far the structure of the abdomen has alone been considered. The cephalothorax it is not now my intention to touch upon, and the homologies of the segments of the appendages have lately been fully discussed by Gaubert. Without either accepting or rejecting the opinion of this author on the subject of the homology of the so-called *patella* of the limbs, it may be interesting to state that the segmentation of the second pair or palpi is not to my mind satisfactorily explained on the hypothesis that this segment results from the subdivision of the *tibia.* For throughout the class of Arachnida—setting aside some aberrant groups—the palpi curiously enough, considering the general plasticity of the limbs, present the same number of segments—namely six. This similarity in the number would lead one to think *à priori* that the separate segments are numerically homologous each to each throughout the class. So far as the Scorpiones, Pseudoscorpiones, Solifugæ, and Pedipalpi are concerned, there can be very little doubt upon this point. But according to Gaubert this is not the case with the Araneæ and Opiliones; for according to this author the fourth segment or *tibia* of the palp of e. g. *Phrynus* is homologous to the fourth and fifth—the *patella* and *tibia*—of the palp of a Spider or an Opilio. But if this is so, the last two segments of the palp of *Phrynus* are represented by a single segment in the two other groups. That such a double dissimilarity has arisen, I am not at present prepared to believe.

These considerations, coupled with the great resemblance between the fourth segments of the limbs in *Thelyphonus* and *Scorpio*—segments which, according to Mons. Gaubert, are not homologous, that of *Thelyphonus* being a *patella* while that of *Scorpio* is a *tibia*—seem to me to be serious obstacles to an otherwise plausible theory.

So far as the mandible is concerned, there is not much that need be repeated here. With the possible exception of some Acari, the greatest number of segments for these appendages is three. Three are found in the Scorpiones, most Opiliones, and the Palpigradi; the basal one, however, has disappeared in the Pedipalpi, Araneæ, Pseudoscorpiones, and some Opiliones. The Solifugæ, too, are usually said to resemble the Araneæ in having two-segmented jaws; but in reality they appear to have the primitive number, namely three; the basal one, however, has hitherto never been recognized, on account of its fusion with the cephalic shield. It is, nevertheless, a more or less distinctly defined sclerite to which the rest of the jaw is articulated.

A further peculiarity in the mandibles of the Solifugæ is the inferior position of the terminal segment or fang with respect to the apophysis of the penultimate segment, to which it is opposable. Also in the male there is a peculiar process on the penultimate segment. Peculiar processes are also found on the same segment of the mandible in both sexes of the Pseudoscorpiones; the movable dactylus, too, is almost inferior. Mainly on these two points of similarity, Mons. Simon has expressed the belief that the affinities of the Solifugæ are with the Pseudoscorpiones—an hypothesis which is further supported by the absence of a cephalothoracic sternum and a close similarity in the number of abdominal segments.

Another system of organs, which no doubt, if more were known of their structure, would throw light upon the affinities of some of the orders of Arachnida, is the eyes.

The ancestral form we believe to have been furnished with two sets of visual organs, which differed in structure and mode of development. These median and lateral eyes are well shown in the Scorpiones, most of the Pedipalpi, and most Araneæ. But there is a marked tendency in many of the 'higher' forms to the disappearance of some or all of the eyes. In the higher Opiliones the median only are retained. This also appears to be the case in the Solifugæ. In the Pseudoscorpiones, on the contrary, the median seem to have disappeared and one or more of the lateral often retained. But until the histology and embryology of these organs has been worked out in this group, in the Acari and in *Stylocellus*, their true systematic importance cannot be understood. For it is most interesting to note that *Stylocellus*, which is a true Opilio, possesses *two* eyes on each side of the carapace, one raised upon a tubercle, the other at the base of the tubercle. This last eye has disappeared in the closely allied genus *Pettalus*, which thus resembles the higher Opiliones in being furnished with only two eyes, but whether or not they are homologous to the two eyes of a *Phalangium*, I am not able to say. If they are not, the fact will constitute a radical difference between the Sironidæ (*Siro*, *Pettalus*, *Stylocellus*), constituting Thorell's suborder Anepignathi, and his Laniatores and Palpatores. Certainly the two eyes of *Pettalus* from their position strongly call to mind those of the Pseudoscorpiones and of the unplaced genus *Gibbocellum* of Stecker. But until the exact nature of all these eyes has been determined by a study of their development and minute structure, no very great taxonomic value can safely be placed upon them.

Having thus passed in review the most important external organs of the Arachnida, it seems to me that the best characters for the classification of the class are to be found in the abdomen.

The following grouping of the orders of Arachnida will serve to show briefly my present views as to their affinities:—

A. The embryo provided with six pairs of abdominal appendages, the second of which persists in the adult as the pectines. The adult with four pairs of abdominal breathing-organs in the form of lamellar tracheæ; the abdomen very long, the posterior five segments compressed to form a flexible tail; the post-anal sclerite furnished with two poison-glands; viviparous.......... Subclass **Ctenophora.**

Order 1. SCORPIONES.

B. The embryo not provided with more than four pairs of abdominal appendages, the second of which are never retained as external organs in the adult. Not more than two pairs of abdominal breathing-organs. Post-anal sclerite usually absent and never provided with poison-glands; abdomen much shorter, with at most the three posterior segments narrowed to form a tail, usually oviparous.................... Subclass **Lipoctena.**

A. Cephalothorax and abdomen separated by a deep constriction; the first abdominal stomite or its remnants covering the apertures of the generative organs and of the first pair of respiratory stigmata. The breathing-organs, except in some of the Arachnomorphous spiders, in the form of lamellar tracheæ; with rare exceptions, there are eight eyes arranged in median and lateral groups .... **Caulogastra.**

Order 2. PEDIPALPI.
3. ARANEÆ.

B. Cephalothorax and abdomen not separated by a deep constriction; the first abdominal sternite not acting as an operculum to the anterior abdominal respiratory stigmata. Breathing-organs in the form of tubular tracheæ. Usually a single pair of eyes, rarely two pairs.

a. A pair of respiratory stigmata between the fourth and fifth cephalothoracic appendages. The posterior two cephalothoracic somites not covered by the cephalic shield. The posterior legs with a series of racquet-shaped tactile organs on the two basal segments; the trochanter of the two posterior pairs of appendages bisegmented, &c. .... **Mycetophora.**

Order 4. SOLIFUGÆ.

b. No stigmata between the coxæ of the fourth and fifth appendages. The cephalothorax covered by a continuous shield. The posterior legs without racquet-shaped tactile organs, and the trochanters of all the legs undivided &c. .... **Holosomata.**

Order 5. PSEUDOSCORPIONES.
6. OPILIONES.
7. ACARI.

This classification differs considerably from that proposed by Prof. Lankester in his article "*Limulus* an Arachnid" already mentioned. This author united the Scorpiones, Pedipalpi, and Araneæ in a group termed Aerobranchia, while the Solifugæ, Pseudoscorpiones, Opiliones, and Acari constituted a corresponding group, Lipobranchia. This terminology, however, does not allow for the fact that nearly all the higher Araneæ are partially or wholly Lipobranchiate.

Moreover, although the Opiliones, Pseudoscorpiones, and Acari were placed in the same section of the Class, it appears from the genealogical tree published in the paper referred to above that these three orders have had an independent origin, the Acari being an offshoot from the stem of the Araneæ, the Pseudoscorpiones from that of the Scorpiones, and the Opiliones from the Solifugæ. If this be so, it is not easy to see upon what grounds the Lipobranchia can be considered a natural group.

As for Dr. Thorell's genealogical tree, enough has already been said to show how materially this author's opinions differ from my own. It may be added, however, that the Solifugæ are removed from the Arachnid phylum and attached to that of the Hexapoda and Myriopoda, a view which to me is quite unintelligible.

* * * * *

It now remains to be seen if any beneficial results can be ascribed to the structural modifications that we have endeavoured to trace right through the Arachnida, starting with the Scorpiones and ending with the Acari.

At the outset of this article it was concluded upon morphological and embryological grounds that the ancestor of the Arachnida was an animal composed of 18 distinct somites, which were divisible into three categories, composed of 6 somites each. The appendages of the anterior six were of large size and were set apart as organs for locomotion and for prehension and mastication of prey; those of the succeeding six were of small size, the posterior four of them disappearing in connexion with the development of four pairs of abdominal breathing-organs. The six somites of the last category were without appendages, and constituted what may be termed a caudal termination to the body. Now it seems perfectly clear that an Arthropod of this description would be most unfitted for terrestrial life on account of the clumsiness of its build. In fact, being forced to drag along a long, trailing, heavy, legless abdomen it could not be otherwise than sluggish, and would consequently find no little difficulty in gaining a livelihood by the capture of other terrestrial Arthropods, which, if not otherwise protected, are usually characterized by extreme activity. It would consequently be an undoubted benefit to our hypothetical ancestor if the caudal termination to its body could be either dispensed with or turned to some account.

The latter end could be without difficulty attained by the lateral compression of the segments, which would confer considerable flexibility upon them. Moreover, since, as we have seen, the last segment was furnished with a post-anal, probably pointed, sclerite, it seems clear that a formidable weapon of attack and defence might be thus constituted. But its greatest use would probably be to put a speedy end to the struggles of prey that had been seized by either one or the other of the prehensorial limbs. In this capacity its efficiency would be greatly increased by the development of a poison-gland in the telson. A concomitant advantage in the development of this "tail" would be a loss in the weight to be dragged by the limbs owing to the decrease in the size of the segments.

In some such manner as this we may imagine that the group of Scorpiones has been evolved. But it does not seem probable that any other group of Arachnida has been derived from them. For it appears hardly likely that any variations tending to the obliteration of so useful an organ as the "tail" would be preserved. But we can without much difficulty imagine that the rest of the Arachnida are the descendants of our hypothetical ancestral form; but the line of their evolution is quite different from that taken by the Scorpions.

The disadvantage that this form would be under from the great and useless development of its posterior abdominal segments has already been pointed out, and we have seen that the difficulty has been overcome in the case of the Scorpions by the conversion of these segments into a light and easily carried, flexible, destructive tail. But clearly another method of dispensing with this cumbrous caudal prolongation would be its suppression by the shortening of the whole abdomen along its longitudinal axis. At first it would still retain its full complement of segments, namely twelve, and the last of them would be furnished with the telson. But owing to the loss of flexibility in the abdomen, this telson would be of no use as an organ of offence or defence. Where it is retained, as in *Thelyphonus*, *Schizonotus*, and *Kœnenia*, it functions merely as an organ of touch, being studded with tactile hairs, and to add to its efficacy in this respect the posterior segments of the abdomen are narrowed to form a movable supporting stalk for it. In *Schizonotus* it retains its original form as a single sclerite either cylindrical or cordate in shape, while in *Thelyphonus* and *Kœnenia* it is a long multiarticulated flagellum. In these three cases greater range of movement is conferred upon this instrument, and its utility is thereby increased, by the increase in the flexibility of the abdomen brought about by the constriction between it and the cephalothorax. Furthermore in *Schizonotus*, in which the organ is very short, we find still greater flexibility results from the secondary constriction which marks off the posterior portion of the cephalothorax from the anterior. The result of this double constriction is that the abdomen can be flexed right over the cephalothorax.

In the Pseudoscorpiones and Opiliones the telson has entirely disappeared. There is consequently no great need for mobility in the abdomen, and no constriction appears between it and the cephalothorax. These two regions of the body are thus perfectly continuous throughout their width, and there is nothing to prevent the two regions from fusing. In the Opiliones, as we have seen, this takes place to a very great extent, the result being a decrease in the length of the body, which no doubt can thereby be carried with considerably less effort by the legs. In this connexion it is interesting to note that when the body is relatively large in this group, as in

e. g. *Trogulus* and *Stylocellus*, the legs are short, robust, and presumably stronger; but when the body is smaller, owing to a decrease in its length, as in *Phalangium*, the legs are extremely long and thin; so that I think there can be very little doubt that in this last-named form and its allies the body is shortened and lightened that it may be raised more easily upon the long stilt-like limbs.

The structure of the Opiliones and Acari is most favourable for shortening by the concrescence of the abdomen with the cephalothorax, for not only is there no constriction between these two regions, but the wide space that separates the coxæ of the posterior walking-legs allows of the forward migration of the anterior abdominal sternites beneath the lower part of the cephalothorax. In the Pseudoscorpiones and Solifugæ, however, the concrescence cannot take place to the same extent, owing to the union in the middle line of the coxæ, this union forming an impassable barrier to the forward movement of the genital aperture.

In the Pedipalpi, as we have seen, as also in the Araneæ, no fusion between the cephalothorax and abdomen is possible, owing to the constriction between them. So that in *Phrynus*, where the body is much shorter than in *Thelyphonus*, we find that the shortening of the abdomen is brought about by the reduction in length of the anterior and posterior somites.

In connexion with the cephalothoracic limbs there is much of interest to note.

In the Scorpions, in which the body is very heavy, and in which the large prehensorial chelæ have to be carried aloft to act as clumsy organs of touch, it is not surprising that four pairs of limbs are required for purposes of locomotion. The Pseudoscorpiones also have heavy prehensile and tactile chelæ; so, too, in this group there are four pairs of walking-legs. But in the Pedipalpi, in which the body is lighter than in the Scorpiones, it seems that three pairs of legs are sufficient for locomotion, for the third pair of appendages fulfil the much needed function of antennæ. So, too, do many Spiders use this same pair of legs as feelers and move with comparative freedom on three pairs. The same is true of the Solifugæ. In both these groups, moreover, there are no heavy palpi to be carried, and it must be a distinct advantage, so far as agility is concerned, for the mandibles to be adapted for seizing and killing prey; for these appendages, although enlarged for the purpose, must be very much lighter and more easily carried than the unwieldy prehensorial palpi of the Pedipalpi, Scorpiones, and Pseudoscorpiones.

So far as internal organization is concerned, it is interesting to note that the great development of the abdomen in the Scorpions is correlated with a serially gangliated nervous chord, a many-chambered heart, and four pairs of breathing-organs. In all the other Arachnida in which the abdomen is shortened, and its muscularity diminished, the nervous chord is simplified by the disappearance of the ganglia, the chambers of the heart are reduced in number, and the two posterior breathing-organs atrophy.

It is evident that in the Scorpions the posterior region of the abdomen is the seat of great muscular activity. To repair the muscular tissue and to absorb its waste products a rich supply of blood is required, and the oxygenation of this blood will be more efficiently performed by four pairs of lung-sacs than by fewer. But in all other Arachnida the abdomen is little more than a vehicle for carrying generative and alimentary glands, so that, seeing that in the Scorpions four pairs of lungs are sufficient, it is not surprising that the rest of the Arachnida have been able to dispense with two pairs.

Again, with regard to the position of the apertures of the breathing-organs, it has already been pointed out that in *Thelyphonus* and *Phrynus*, which retain the so-called lung-books, these apertures lie in front of sterna of the somites containing the lungs. A beneficial result of this arrangement is that the sterna in front of the apertures form movable opercula to them, so that they can be opened and closed at will. In the Araneæ, where the terga and sterna mostly atrophy, we find the remnants of these sterna retained as the opercula. In the higher Araneæ (Dipneumones) the posterior pair of pulmonary sacs are replaced by tracheal tubes, the apertures of which in most forms take advantage of the continuity of the integument of the lower surface of the abdomen to migrate to its hinder end in the wake of the spinning-appendages.

In the Solifugæ the apertures of the abdominal tracheæ are very small. In most forms, e. g. *Solpuga,* they are visible on the surface of the sterna, but in *Galeodes* they have moved posteriorly until they lie behind the sterna and are thus capable of being closed. This, as well as the small size of the stigmata, must be an advantage to an animal living in desert countries, where sand would be liable to block the breathing-tubes.

Another interesting point in connexion with these animals is that a second pair of breathing-organs occurs on the ventral surface of the cephalothorax behind the coxæ of the fourth appendages, as if to compensate for the small size of the abdominal stigmata. The apertures of these organs must be less likely to get blocked by sand than those of the abdomen, owing to their being removed away from the surface of the ground, and only very much exposed when the coxæ between which they lie are separated by the movement in the vertical plane of the posterior half of the cephalothorax.

In some Pseudoscorpiones, too, the stigmata have also changed their position, but instead of moving backwards as in the Solifugæ they have migrated externally from the sternal plates to the lateral membrane of the somites. In this situation they are much more freely exposed to the air and much less likely to be blocked by sand or earth or other foreign bodies.

In the Opiliones the stigmata of the remaining pair of breathing-organs retain their position in the middle of the sterna of the somite to which they belong.

From what has been already said concerning the affinities of the orders of Arachnida, it will be seen that the replacement of pulmonary sacs by tracheæ has taken place independently at least twice—once in the Dipneumonous Spiders, and once in *e. g.* the Pseudoscorpiones. This fact goes a long way towards weakening the evidence of affinity between the Opiliones and Pseudoscorpiones, not to mention the Solifugæ, on the grounds of similarity in their breathing-organs. For the replacement may have been independently brought about in the three cases. But however this may be with regard to the three orders just mentioned, the fact that these tubes have been developed twice in the same group bears very strong evidence as to their efficacy as breathing-organs. They must in fact be better adapted for their purpose than the lung-book tracheæ. Perhaps the following considerations may throw some light upon the matter. It seems that an Arachnid furnished with tracheal tubes, such as *Galeodes*, must be considerably lighter and consequently more agile than one, like a Scorpion, which possesses pulmonary sacs. The loss of weight will be due to two causes: firstly, to the fact that there will be a much greater supply of air inside the body, owing to the ramifications of the air-tubes through the tissues; and, secondly, to the fact that the blood will be reduced in quantity, for there will no longer be need for a rich supply of it, since the oxygen will be carried directly to all parts of the body by the branches of the tubular tracheæ.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Diagram to show fundamental plan of Arachnid structure. I.–VI., cephalothoracic appendages; *c*, carapace; *m*, median, and *l*, lateral eyes; 1–12, abdominal somites; *t*, telson; *x*, anus; α–ζ, abdominal appendages; *g*, generative aperture.

Fig. 2. Semi-diagrammatic figure of a Scorpion. Lettering as in fig. 1. α, genital operculum; β, pectines; 3′–6′, sterna bearing the four pulmonary sacs which correspond to γ–ζ of fig. 1. (N.B. The coxæ of the posterior two cephalothoracic appendages have been omitted so as to show the genital operculum and the pectines.

Fig. 3. Fig. of a *Thelyphonus.* Lettering as above. *w*, waist or constriction between cephalothorax and abdomen; 1–4, anterior four tergites of abdomen, represented on the ventral side by three sternites, 1′–2′, 3′, 4′; 10–12, posterior three abdominal somites forming the movable stalk for the antenniform telson.

Fig. 4. *Schizonotus.* Lettering as in fig. 3. *c*′, supernumerary cephalothoracic tergite.

Fig. 5. Diagram of *Phrynus* to show the absence of the telson and the reduction in size of the posterior abdominal tergites and sternites.

Fig. 6. Diagram of the anterior five abdominal somites of *Thelyphonus* or *Phrynus*, to illustrate the hypothesis that explains why the pulmonary sacs of the 3rd and 4th somites open behind the 1st and 2nd sterna. 1–5, abdominal somites; *op*, sternum of the 1st (? 2nd) forming the operculum of the anterior pulmonary sacs and of the genital orifice; p^1, anterior, p^2, posterior pulmonary sacs.

Plate II.

Fig. 7. *Liphistius desultor*, to show the persistence of most of the abdominal tergites and of the two anterior sternites. The 1st tergite forms the dorsal plate of the abdominal pedicle, and the 12th the dorsal plate of the anus. Similarly the 12th sternite persists as the ventral plate of the anus. The appendages marked ϵ, ζ in fig. 1 persist as the spinning-mammillæ, m^1, m^2.

Fig. 8. Diagram of one of the Mygalomorphous Araneæ to show the disappearance of the external segmentation, the persistence of parts of the sterna as respiratory opercula (s^1, s^2), and the migration of the mammillæ to the posterior end of the abdomen.

Fig. 9. Diagram of a Dipneumonous Spider (*Dysdera*), to show the replacement of the posterior pulmonary sacs by a tracheal tube (s^2).

Fig. 10. Diagram of another Dipneumonous Spider (*Epeira*), to show the migration of the tracheal tubes to the hinder end of the abdomen.

Fig. 11. Diagram of one of the Pseudoscorpiones (*Garypus*), to show the terga and sterna of the abdomen, also the presence of the stigmata in the 3rd and 4th somites and the single generative sternite (*g*) corresponding to the 1st and 2nd tergites.

Fig. 12. *Stylocellus javanus*, one of the Opiliones, showing the disappearance of the anterior abdominal somites (after Thorell; slightly modified). 3–12, the tergites; 4–11, sternites; *s*, stigma on the 4th sternite.

Fig. 13. The same from below (also slightly modified from a figure given by Thorell).

Fig. 14. *Gonyleptes* (an Opilio) to show the fusion of the anterior 4 (? 5) abdominal tergites with the carapace and the 4 (1–4) free tergites and 5 (1′–5′) free sternites.

Fig. 15. The same from below, for comparison with fig. 14.

Fig. 16. *Holothyrus* (one of the Acari), for comparison with fig. 13, to show the jointed, chelate mandible, and pediform palpi I., II. (after Thorell). *a*, anus; *g*, position of genital orifice.

Fig. 17. Diagram of one of the Solifugæ, to show the segmentation of the carapace, the basal segment of the mandible (*b*) fused to the cephalic shield, the position of the stigmata on the 2nd and 3rd (morphologically, I think, the 3rd and 4th) segments of the abdomen, and (*s*) the position of the cephalothoracic stigmata.

N.B.—Where I have taken the liberty of utilizing figures published by Dr. Thorell, I wish it to be understood that I have tested their accuracy by an examination of actual specimens.

II.—*Descriptions of Thirteen new Species of Terrestrial Mollusca from South Africa.* By James Cosmo Melvill, M.A., F.L.S., and John Henry Ponsonby, F.Z.S.

[Plate III.]

This, our sixth contribution on the subject, we present in fulfilment of our promise (Ann. & Mag. Nat. Hist. 1892, vol. x. p. 237) to deal with new forms of *Ennea* and *Pupa*. We now describe four of the former genus and seven of the latter.

1. *Helix* (*Pella*) *strobilodes*, sp. n. (Pl. III. fig. 1.)

H. testa obtecte umbilicata, conica, tenui, sordide alba, epidermide sericeo-cornea contecta; anfractibus sex, supra angustatis, infra ad basin rapide accrescentibus, paullum ventricosis; apertura lunari; peristomate tenui, simplici, apud umbilicum triangulatim reflexo.

Long. 7·75, lat. 5·50 mill.

Hab. Tharfield.

A somewhat conical, close-whorled shell, with simple mouth and narrow umbilicus, allied to *H. Loveni*, Krauss.

Two specimens.

2. *Helix* (*Patula*) *somersetensis*, sp. n. (Pl. III. fig. 2.)

H. testa aperte umbilicata, subconico-depressa, lævi, albo-cinerea;

anfractibus quatuor (ultimo rapide accrescente), ad suturas impressis, gradatulis; apertura ovali; peristomate tenui, simplici.
Long. 2, lat. 1·50 mill.

Hab. Somerset East (*Miss M. L. Bowker*).

A shell of simple character, with a superficial resemblance to *H.* (*Vallonia*) *pulchella*, Müll. In the collection of E. L. Layard, Esq.

Two specimens.

3. *Pupa tabularis*, sp. n. (Pl. III. fig. 3.)

P. testa minuta, subdiaphana, cylindrica, brunneo-succinea, lævi; anfractibus 5–6, ventrosulis, ad suturas compressis; apertura rotunda; peristomate planato, minime reflexo, albescente, dente parietali conspicuo, intrante.
Long. 3, lat. 1·50 mill.

Hab. Cape Town (*R. M. Lightfoot, Esq.*).

Recalls to some extent the British and European species *P. muscorum*, Linn. The whorls are somewhat ventricose, shining brown, and smooth; the peristome flattened, parietal tooth large and conspicuous.

Several specimens.

4. *Pupa dysorata*, sp. n. (Pl. III. fig. 4.)

P. testa minutissima, oblonga, lævi, apice obtuso; anfractibus 7–8, ventricosis, ad suturas compressis; apertura ovali; peristomate albido, paullum reflexo, ad marginem columellarem incrassatum unidentato.
Long. 2, lat. ·55 mill.

Hab. Griqualand East (*E. R. Sykes, Esq.*).

A microscopic, oblong, narrowed species of dull plain substance; whorls ventricose; peristome ovate, with one tooth on the somewhat broadened columellar margin.

5. *Pupa quantula*, sp. n. (Pl. III. fig. 5.)

P. testa minutissima, rimata, diaphana, brunnea, cylindriformi, apice obtuso; anfractibus sex, microscopice tenuiliratis, valde ventricosis, præsertim tribus mediis; apertura ovato-rotunda; peristomate simplici, reflexo.
Long. 2, lat. ·85 mill.

Hab. Port Elizabeth (*J. Crawford*).

Exceedingly minute, with simple mouth and remarkably swollen ventricose whorls, especially the third, fourth, and fifth, and cylindriform in shape; it is longitudinally striated, but so minutely as to be almost invisible even with a fairly strong lens.

Three specimens.

6. *Pupa Sykesii*, sp. n. (Pl. III. fig. 6.)

P. testa minuta, rimata, cylindrica, diaphana, apice obtuso; anfractibus quinque, tumescentibus, ventricosis, undique confertim exquisite longitudinaliter tenuicostatis; apertura ovata; peristomate paullum reflexo, colorato, duobus dentibus munito, hoc parietali, illo basali, oppositis, inconspicuis.

Long. ·90, lat. ·75 mill.

Hab. Griqualand East (*E. R. Sykes, Esq.*).

Another very small but exquisite little species. It is obtuse, cylindrical, with tumid whorls; the teeth of the peristome are with difficulty distinguished with a lens; they are opposite to one another, one parietal, the other basal. The shell is umbilicated, with the outer columellar margin of the lip reflected to some extent over the umbilicus, and the tumid whorls are everywhere ornamented with fine oblique longitudinal striæ.

7. *Pupa haploa*, sp. n. (Pl. III. fig. 7.)

P. testa oblongo-pyramidata, tenuissima, apice obtusato; anfractibus septem, ventricosis, undique longitudinaliter tenuistriatis, apud suturas impressis; apertura ovali; peristomate incrassatulo, simplici.

Long. 1·70, lat. ·75 mill.

Hab. Pretoria.

A very small oblong species, with simple and very slightly thickened peristome.

8. *Pupa pretoriensis*, sp. n. (Pl. III. fig. 8.)

P. testa minutissima, tenui, cinereo-brunnea, apice applanato, contabulato; anfractibus quinque, valde ventricosis, undique longitudinaliter tenuistriatis, tribus ultimis latitudine æqualibus; apertura rotunda; peristomate incrassatulo, simplici, apud marginem columellarem reflexo.

Long. 1, lat. ·55 mill.

Hab. Pretoria.

Exceedingly small, with simple mouth, and peristome slightly incrassate. The whorls are five in number, very ventricose, all longitudinally finely striate; apex extremely flattened and broad.

9. *Pupa griqualandica*, sp. n. (Pl. III. fig. 9.)

P. testa minutissima, rimata, tenui, rotundo-cylindrica, brunnea; anfractibus quinque, ventrosulis, apud suturas compressis, undique confertim longitudinaliter tenuistriatis, ultimo anfractu in medio dorsualiter juxta labium exterius depresso-sulcato; apertura ovato-rotunda; peristomate incrassato, ad marginem labialem unisinuato, plicato, plicis parietalibus duabus, valde prominentibus, recurvis, tertia, marginem apud columellarem, dentiformi.

Long. 1, lat. ·75 mill.

Hab. Griqualand East (*E. R. Sykes, Esq.*).

Extremely small, but with a wonderfully complicate mouth, being furnished with three plaits, one of them being prominent, straight, and parietal, the second also parietal, central, somewhat recurved and very pronounced and distinct, extending nearly two thirds of the diameter of the orifice, in a slightly oblique direction; the third plait is tooth-shaped and towards the columellar margin. The shell is thin, finely longitudinally striate, with five whorls, which are tumid, and compressed at the sutures.

Three or four specimens.

10. *Ennea distincta*, sp. n. (Pl. III. fig. 10.)

E. testa subrimata, cylindriformi, obtusa, pallide cornea; anfractibus octo, quorum tribus ad apicem brevibus, quatuor latitudine fere uniformibus, ultimo ad basin paullum producto, undique oblique regulariter densistriatis; apertura ovato-rotunda; peristomate nitente albido, reflexo, dentibus quatuor instructo, tribus parvis labialibus, uno parvulo ad basin, plica columellari interna, planata, subtus margiuem intrante.

Long. 12, lat. 4·50 mill.

Hab. Middleburg, Transvaal (*J. Crawford, Esq.*).

A conspicuous and proportionately large species of *Ennea*, of a delicate straw-brown colour, shiny white peristome, with prominent parietal plait, and furnished with four small teeth—one being close to the aforesaid plait, two at the labial inner margin, one at the basal,—the columellar plait being deep-seated and below the outer peristome; the shell is barrel-shaped, very obtuse at the apex, and cylindrical, eight-whorled, and beautifully obliquely finely striated.

Five specimens. Allied to *E. Albersi.*

11. *Ennea regularis*, sp. n. (Pl. III. fig. 11.)

E. testa rimata, tenera, obtusa, subhyalina, ochreo-nivea, cylindrica; anfractibus sex, undique longitudinaliter oblique tenuistriatis, ad suturas compressis; apertura ovata; peristomate reflexo, plicis duabus dentibusque quatuor instructo, plica parietali magna, valide intrante, columellari interna, mammæformi, dentibus duobus ad marginem labialem, tertio ad basin, quarto parvulo columellari.

Long. 7, lat. 3·50 mill.

Hab. Cope's Folly, Maritzburg (*H. Burnup, Esq.*).

A neat, delicate, and chaste species, albeit of moderate dimensions. It is white, with an ochraceous tinge, cylindrical, obtuse at the apex, six-whorled, the whorls being very compressed at the sutures, so much so as almost to appear channelled; the aperture is ovate; peristome shining white and reflexed, furnished with a parietal plait of conspicuous size and projection, also a columellar plait, internal and nipple-shaped. Besides this there are four teeth, two labial, the lower being the larger, one at the base, and one columellar.

One specimen.

12. *Ennea perspicua*, sp. n. (Pl. III. fig. 12.)

E. testa subrimata, pellucida, vitrea, tenui, cylindrica, apice obtuso; anfractibus septem, lævibus, compressulis; apertura ovata; peristomate reflexo, biplicato et bidentato, plica parietali magna prominente, columellari interna valde intrante, dente labiali conspicuo, basali parvo.

Long. 4, lat. 2·25 mill.

Hab. Transvaal.

Very small for the genus, but of beautifully shining and transparent texture, with the whorls quite smooth and the mouth with a complicated arrangement of teeth and plaits, two of each—the parietal or sutural plait being thin, sharp, and prominent, the labial tooth conspicuous and large, the basal smaller; the columellar plait very distinct and wholly internal.

Two specimens.

13. *Ennea Collieri*, sp. n. (Pl. III. fig. 13.)

E. testa cylindriformi, pellucida, tenui; anfractibus septem, ventricosis, ad suturas compressis, undique longitudinaliter suboblique costulatis; apertura rotundo-ovata; peristomate albo, nitido, duabus plicis et dente uno instructo, plica parietali multum prominente, acuta, plica interna subtus marginem columellarem lata, dente uno labiali.

Long. 7, lat. 4 mill.

Hab. Pretoria. In coll. Edward Collier, Esq.

A transparent shining little species, with regularly costulate whorls, ventricose, seven in number; the shell is cylindriform in shape; peristome shining white, somewhat translucent, as is the rest of the shell, furnished with a prominent acute parietal fold and an internal broad plica behind the columellar margin of the peristome. There is also one simple labial tooth.

Two specimens, one of which is slightly more elongate than the other.

EXPLANATION OF PLATE III.

Fig. 1. *Helix strobilodes.*
Fig. 2. —— *somersetensis.*
Fig. 3. *Pupa tabularis.*
Fig. 4. —— *dysorata.*
Fig. 5. —— *quantula.*
Fig. 6. —— *Sykesii.*
Fig. 7. —— *haploa.*
Fig. 8. *Pupa pretoriensis.*
Fig. 9. —— *griqualandica.*
Fig. 10. *Ennea distincta.*
Fig. 11. —— *regularis.*
Fig. 12. —— *perspicua.*
Fig. 13. —— *Collieri.*

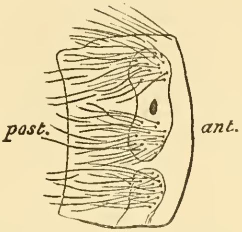
III.—*Additional Notes on the Origin of the Tracheæ from Setiparous Glands.* By Henry M. Bernard, M.A. Cantab. (from the Huxley Research Laboratory).

In the last issue of the 'Zoologische Jahrbücher' (Bd. v.) I brought forward some evidence in favour of the derivation of the Arthropodan tracheæ from setiparous glands, and pointed out how this derivation might be made to explain many of the difficulties which at present beset this subject. I propose here to bring forward a few more arguments tending in the same direction.

(1) I endeavoured to show that in the Myriapoda, while we could deduce the tracheæ from the notopodial acicular glands, the stink-glands which occur dorsally to the stigmata might be the glands of the original parapodial setæ. Mr. Pocock, of the British Museum, kindly informs me that in the Chordeumidæ, which appear in many respects to be intermediate forms between the Iulidæ and the Polydesmidæ, the foramina repugnatoria of these latter are not to be found, but setæ develop apparently exactly on the spot where these glands ought to occur, and, further, that in the Polyxenidæ a great tuft of setæ grows in the same spot, apparently in place of the stink-glands which are wanting, and, again, a still more important fact, that in *Scolopendrella*, in which animal the

stigmata are confined to the head, large setæ spring from the sides of the segments in the place where stigmata occur in all the Chilopoda and Hexapoda. This curious retention of so many primitive Annelidan characteristics on the part of the Myriapods is after all what one might expect from animals so clearly Annelidan in their rich segmentation.

(2) The arrangement of the stigmata, hairs, and pigment in the pupa of the vapourer moth (*Orgyia antiqua*) is very suggestive. The deep black pigment of the skin is relieved at the sides of the abdominal segments by clear white or whitish patches, running dorso-ventrally and nearly meeting in the ventral middle line. The arrangement is shown in the woodcut. On each side of the stigma is a very definite, more or less circular field covered with long setæ. It is true that the greater part of the dorsal surface is covered with long setæ, but no one can examine these setigerous areas under the microscope without being convinced that they are distinct regions. If this arrangement is compared with an Annelidan parapodium, the similarity in the position and arrangement of the setæ is very striking. The stigma corresponds to the opening of the acicular gland and the setigerous areas to the setigerous regions of the parapodium on each side of the aciculum. It was especially the aciculum of the dorsal parapodium to which I referred the stigmata of the Hexapoda. We have here, then, traces of a complete dorsal parapodium, as shown in the figure, while beneath it is seen the dorsal part of the ventral parapodium with a similar setigerous area well marked off. More ventrally (not shown in the figure) the white patch is continued, but without setæ, almost to the median line. It is the ventral parapodium which I have suggested formed the leg of the Hexapoda.



Lateral view of an abdominal segment of a pupa of a female Vapourer Moth, showing the "parapodial scars."

Why these extraordinary "parapodial scars," as I propose to call them, should suddenly appear on the pupa is a problem

I cannot pretend to solve. It may perhaps be referred to the force of heredity coming into action as soon as the animal is more or less withdrawn from the struggle for existence, as a pupa may almost be said to be when encased in a cocoon.

(3) In order to get more light on the homologies of the ventral row of structures in the Arachnids which I propose also to refer to a row of setiparous glands, I have naturally turned my attention to some of the less known orders. A small Chernetid, apparently an *Obisium*, has yielded me unexpected results.

The stigmata of the tubular tracheæ on the second and third abdominal segments are followed by a *complete row of segmental apertures running along each side to the end of the abdomen.* Their position corresponds exactly with those of the stigmata, and I think it is impossible to doubt that they are homologous with these latter. In this interesting Arachnid, then, there are *nine pairs of apertures on the nine posterior abdominal segments.* The two anterior pairs are stigmata. The function of the other seven, for want of sufficient material, I have not yet made out. It is well known that the Chernetidæ spin webs, and there seems to be no very clear idea where the glands are situated. Croneberg's claim * that the spinning-gland opens on the mandibles is probably correct. I find a very distinct aperture on a small prominence behind the point of the movable piece of the mandibles. In that case these "stigmata" may be purely rudimentary and functionless. If, on the other hand, these seven pairs of apertures following on, and evidently homologous with, stigmata prove to be the openings of spinning-glands (a point I hope soon to investigate), we should have a remarkable confirmation of my suggestion that the lung-books or tracheæ and the spinning-glands of the Araneids are homologous structures as common derivatives from setiparous glands. We learn also from these *nine* pairs of abdominal apertures in *Obisium* that the limitation of the number of stigmata in *Scorpio* is not original, *i. e.* inherited from a *Limulus* ancestor, but is due to a secondary reduction of what were originally segmental structures along the whole abdomen.

(4) The coxal gland of *Galeodes* opens, as Sturany † suspected, between the third and fourth appendages, *i. e.* on the coxa of the first leg. Dufour, who mistook it for a sali-

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* "Beitrag zur Kenntniss des Baues der Pseudoscorpione," Bull. Soc. Imp. Nat. de Moscou, t. ii. (1888).

† "Die Coxaldrusen der Arachnoiden," Arb. Zool. Inst. Wien, t. ix. (1891).

vary gland, nevertheless correctly described its different appearance in different Galeodidæ. In some it is a simple long tube commencing in the region of the second leg, running backward to form a tangled coil between the nerve-cords in the region of the third and fourth legs. It then bends forward again to open in the above-mentioned spot. In others the proximal end of the gland divides up into a sponge-like mass of anastomosing tubules, which, uniting with those of the gland on the opposite side, form an amorphous mass arching over the mid-gut. The course of the duct and the position of the aperture agree almost exactly with that described by Sturany for the coxal gland of *Atypus.*

The points which especially interest us here, however, are the following. The aperture of the gland on the coxa of the first leg agrees almost exactly in position with the aperture of the tracheæ on the coxa of the second leg, which suggests their being homologous structures. The duct shows the characteristic striped appearance, as if its wall were pitted by countless pores. It stains very badly, and although it will not stand boiling in caustic potash, resists the action of cold caustic potash. There seems to me to be little doubt that chitin is present in its walls, although it nowhere forms a definite lining to the tube. The retention of the gland in *Galeodes* as an important functional excretory organ, while it has degenerated in the Araneidæ, although once well developed in these latter, suggests a correlation between these coxal glands and the spinning-glands. The development of the spinning-glands to utilize and carry off excretory products renders the coxal glands unnecessary. This correlation is the more probable if both glands can be referred back to setiparous glands. The same may be said of the mandibular poison-glands, which are well developed in the Araneids, but absent in *Galeodes.*

Besides the fact mentioned in my first contribution on this subject, that no difference can be discovered between the tracheæ of the thorax and of the abdomen, it also remains to be stated (what indeed has been known since 1848 *) that the tracheæ of the two regions communicate freely with one another. The assumption that the abdominal tracheæ are developed from lung-books while the thoracic tracheæ are independent developments† from ectodermal invaginations, and therefore not in any way homologous with the former, seems

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* Kittary, "Anatomische Untersuchungen der gemeinen *Galeodes* und der furchtlosen *Solpuga,*" Soc. Imp. Moscou, vol. xxi.

† Korschelt and Heider, 'Vergleichende Entwickelungsgeschichte,' p. 638.

to me to ignore the fact that both structures arise in similar positions, viz. at the bases of the limbs. The thoracic tracheæ of *Galeodes* open posteriorly on the coxa of the second pair of legs. In addition, then, to the extreme improbability of the same structure—tracheæ—having had two independent origins in the same animal, we have the further improbability that the openings of the assumed independently developed thoracic tracheæ should bear apparently the same relation to the thoracic limbs as the lungs do to the embryonic abdominal limbs.

These arguments, I think, lend considerable support to my attempt to deduce tracheæ from setiparous glands. The first two points seem to show that the lateral row of stigmata, spinning-glands, &c. found in the Myriapoda and Hexapoda have actually been deduced from the acicular glands of dorsal parapodia, the ventral parapodia forming the legs. Such a confirmation of this part of my original suggestion leads us almost naturally to conclude that the ventral row of tracheæ, spinning-glands, &c. in the Arachnida have been developed from the setiparous glands of the ventral parapodia. If so, the legs of the Arachnids have been most probably developed from the dorsal parapodia, while the ventral parapodia have disappeared in the coxal joints, their setiparous glands, however, persisting as tracheæ &c. This origin of the limb in the Arachnids is exactly what I have elsewhere endeavoured to show must have been the origin of the legs of the Crustacea. This would account for the great similarity between the legs of *Limulus* and those of the Arachnids, and also for their common possession of coxal glands. It would also account for the traces of Crustacean characters found by Jaworowski [*] in the developing limbs in the embryo of *Trochosa singoriensis* [†].

IV.—*On the Terminal Organ of the Pedipalp of* Galeodes *and the Discovery of a Homologous Organ on the Pedipalp of* Phrynus. By HENRY M. BERNARD, M.A. Cantab. (from the Huxley Research Laboratory).

THE remarkable protrusible organ at the tip of the pedipalp of *Galeodes* has, since Dufour's discovery, received but little

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[*] "Ueber die Extremitaten, deren Drüsen, und Kopfsegmentirung bei *Trochosa singoriensis*," Zool. Anz., May 1892.

[†] I regret to have omitted to mention in my former paper what had been a very valuable work of reference to me, viz. Palmén's 'Zur Morphologie des Tracheensystems,' Leipzig, 1877.

attention. Dufour * himself assumed that it was a sucker-like seizing-organ, and this view has again been expressed quite recently †.

A close examination of it shows almost conclusively that Koch's ‡ suggestion that it is a sensory organ, probably olfactory, is correct.

We may at the outset remark, first, that such a minute and delicate seizing-organ in an animal armed like *Galeodes* would be ridiculously out of proportion, and, secondly, that a highly specialized sensory organ might be expected in such swift runners who hunt their prey.

The organ itself is essentially an invagination of the tip of the pedipalp, forming a conical pit, the thin chitinous walls of which are continued into the metatarsus as a tendon to which a powerful muscle is attached. The external aperture of the pit is a transverse slit, which closes like a pair of lips. The upper lip, *i. e.* that on the dorsal or outer side of the limb, is stiff and solid, and is opened by means of a long tendon connecting it with a muscle far down in the metatarsus. The opening of this lip like a lid leads apparently to the slight protrusion of the organ, *i. e.* by drawing it up with it. I could find no other mechanism to explain it.

Within the pit one wall only, *i. e.* the dorsal, is thickly covered with fine sensory hairs, so regularly arranged that the chitinous membrane from which they arise appears like a fine network. The hairs are in evident connexion with a deep sensory epithelium immediately under the chitinous membrane. This epithelium runs a long way down the (hollow?) tendon. The ventral wall of the pit is an exceedingly fine chitinous membrane, against which, when the aperture is closed, the tips of the hairs apparently rest.

If this is not enough to show that this organ is not a seizing but a sensory organ, the discovery of a very similar organ in the pedipalps of *Phrynus* on the inner surface of the most distal claw effectually settles the question. In the adult specimens a sensory area runs longitudinally from the joint along about half the length of the claw; but I was unable to discover any chitinous invagination. In a young specimen, however, which could be clarified, an invagination of this same area was very clear. It occurred on the dorsal side of

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* Dufour, "Anatomie, histologie, et physiologie naturelle des *Galéodes*," Mémoires présentées à l'Institut de France, vol. xvii.

† Bertkau, "Ueber Sinnesorgane in den Tastern und in den ersten Beinpaar der Solpugiden," Zool. Anz., Jan. 1892.

‡ Koch, "Systematische Uebersicht über die Familien der Galeoden," Archiv für Naturgesch., 1842.

the area, and was so arranged that the sensory surface seemed to dip away sideways under the cuticle of the claw, and could then be followed under the microscope through the base of the claw into the next joint. The lower ventral edge of the exposed part of the sensory organ was protected by hairs regularly arranged so as to slant over the delicate surface, while dorsally, where the sensory surface disappears under the cuticle, the slit-like opening is guarded by a regular row of fine hyaline hairs, which rise from the sensory surface and curve over the outer cuticle. Apparently similar hyaline hairs can be focussed down in the lower parts of the invagination. On both old and young curious hairs with heads like narrow dentate leaves occur at each end of the sensory area*.

The finer histological details of this organ in *Phrynus* can only be made out in young specimens when the chitin is not too thick for sectioning. I reserve further details of the organ in *Galeodes* for a comprehensive work which I am now preparing on this animal.

The presence of this presumably olfactory organ in such different Arachnidan types as *Galeodes* and *Phrynus* is of no small interest. The clarified pedipalp of *Scorpio* showed no trace of such olfactory organs. The same must be said of a Chernetid, apparently an *Obisium*, which had been boiled in caustic potash. The pedipalp of a *Telyphonus* was also searched in vain by clarifying rough sections. I unfortunately had no young specimens of this latter at my disposal. It seems to me not improbable that some traces of such an organ might be found in very young animals considering the apparent affinity which exists between *Phrynus* and *Telyphonus*.

Whether the peculiar sexual organs at the end of the pedipalp of the Araneids had any original connexion with such a sensory organ is a point well worth investigating.

V.—*On the Embryology of the River-Lamprey.*

By Ph. Owsjannikow †.

Modern methods, including both serial sections and also the new staining reagents, now enable us to prosecute a much

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* As an index of the accuracy of Koch's figures, the position of this organ is marked by a group of hairs in the drawing of *Phrynus ceylonicus*, plate 776 in vol. x. 'Uebersicht der Arachniden-Systems.'

† Translated from the 'Mélanges Biologiques tirés du Bulletin de l'Académie Impériale des Sciences de St.-Pétersbourg,' t. xiii. livr. i. St. Petersburg, 1891: pp. 55–67.

more precise investigation in the realm of embryology than was possible in former years. Thus it may be readily understood that, thanks to these new scientific processes, many deficiencies which existed also in our knowledge of the developmental phenomena in the Lamprey are supplied by numerous fresh investigations. The new facts bring with them new questions, which have a special interest for comparative embryology. As the publication in their entirety of my investigations upon the development of the Lamprey is not immediately possible, since the exceedingly abundant material from all stages of development must be arranged in proper order, and since also the figures require much time, I have determined to give a short provisional communication, which is at the same time intended to complete the investigations which I made upon this subject nearly twenty years ago.

In the ova of lamprey larvæ, which are from 70 to 90 millim. in length, the germinal vesicle is in many cases already excentric in position. At this period of development, when the contents of the ovum are in a semifluid state, the germinal vesicle may alter its position. I have had occasion to observe in a preparation three young ova in which the germinal vesicle lay between the yolk and the egg-membrane.

The Graafian follicles are clothed with endothelial cells. At the region where the pointed angles of the cells are in contact with one another, which is usually at the upper pole of the ovum, dark spots are to be seen after treatment with nitrate of silver; these may be regarded as entrances into the lymph cavities.

The blood-vessels enter the Graafian follicle at its pointed end, at which spot the active pole of the ovum also lies within the follicular membrane. It is frequently to be observed that the tip of the ovum does not quite touch that of the follicular membrane, while everywhere else the latter is in close contact with the ovum.

In all ova of lampreys which were ready to spawn when they were removed from the ovaries I have observed the germinal vesicle with the greatest distinctness in sections. The germinal spot, however, was not present. On the other hand, in very many ova which were squeezed out of the female for the purpose of artificial fertilization the vesicle could not be detected. In very few cases did it lie near the active pole of the ovum as a small flattened disk of the vitelline membrane. It is hardly open to doubt that in the cases in which the ovular nucleus is not visible its contents have mingled with the elements of the yolk, for all the ova were capable of being fertilized and in all the protoplasmic protuberance was noticeable directly after the act of fertilization.

In order that the several portions of the embryo shall be more readily distinguishable from one another, it is necessary for the preparations to be thoroughly stained. The prevalent idea that the egg-membrane is impervious to stains is erroneous. I found that several staining-fluids penetrate the ovum and the embryo. The ova took the best stain, no matter whether at first treated with Flemming's fluid, alcohol, or osmic acid, by being immersed for from twelve to four-and-twenty hours in a strong saturated solution of hæmatoxylin. A longer immersion causes the yolk-granules to become coal-black.

I possess a large series of sections in which there may be seen all those processes which set in immediately after fertilization, and were observed and described in living ova by A. Müller, Kupffer, Benecke, Calberla, and myself.

By treatment with osmic acid the contents of the ovum are instantaneously hardened, so that in sections we are enabled to get a good view of the protuberance which arises at fertilization as well as the protoplasm, which usually appears on the withdrawal of the yolk from the egg-membrane.

Moreover, in the serial sections we may study the most varied forms of mitoses, which appear at the division of the nucleus before the formation of the new yolk-segments.

The time occupied by the various metamorphoses in the ovum depends upon the temperature at which the fertilized ova are kept. This fact explains why the divisions of the yolk which I previously described in the ova of the lamprey proceeded more rapidly than they were found to do by Calberla. Kupffer states that at Königsberg, when the temperature of the air stood at from 8° to 10° C. (46°·4 to 50° F.), the larvæ were hatched on the sixteenth or seventeenth day, and at Naples at the end of the eighth day. My larvæ hatched out on the ninth or tenth day at an atmospheric temperature of about 16° R. (68° F.).

The first furrow is a longitudinal one, which consequently has a meridional direction and divides the yolk into two perfectly equal portions.

The furrow begins from the nucleus, which for a long time lies almost entirely superficially in the neighbourhood of the active pole.

The first segmentation proceeds exceedingly slowly. We observe long fibres radiating from the nucleus, which are especially distinct and lie closer together at the spot at which the furrow has begun to form.

Before the complete separation of the two segmentation spheres several nuclei appear, and between every two nuclei a spindle becomes visible. It is no doubt partly owing to such a complete separation of the yolk-segments that in the last days of development we find within one egg-membrane two embryos entirely separate from one another, as I frequently had occasion to observe.

The second furrow is likewise longitudinal, and it is only the third that is the first equatorial one.

After fifteen hours the ovum is represented by a vesicle the upper wall of which consists of a series of smaller cells, the lower of much larger ones. Baer's cavity has attained considerable dimensions.

The ova of twenty-eight hours likewise exhibit at the roof of Baer's cavity a single layer of cells.

At the lower pole, however, there lies a group of larger cells. The transition between the smaller cells of the upper pole and the larger cells of the lower is a gradual one.

In ova of fifty-five hours Baer's cavity has reached a still larger size.

The smallest cells lie at the upper pole and already have an epithelial character about them. In many sections the ovum has the appearance of a ring, which at one spot, namely at the upper pole, consists of one layer, while it is bi- or trilaminate at the other. Sometimes there lies at the lower pole a small group of segmentation-spheres. Even at this period a Rusconi's pit is visible upon the under surface of the ovum. The cells of the outer layer gradually pass into the floor of the pit. The shape of this pit leads us to suppose that it has arisen by the invagination of the outer layer, as is actually the case. This structure is nevertheless a transitory one; at any rate its appearance very soon changes. The largest cells are found in the pit of Rusconi and at its margin.

When eighty hours have elapsed the outer layer has undergone still further modification; the cells have become still more cylindrical and have almost entirely consumed the yolk-granules. The size of the segmentation-cavity has in the meantime greatly diminished. The whole of the lower half of the ovum consists of small round cells, which, however, are separated by a slight space from the still smaller and much more closely packed cells of the epiblast. The anus of Rusconi can at this time be seen with great distinctness at the lower pole, though it has undergone a change in form and has become narrower and longer. The ovum itself has also grown longer and has become pointed at one end. This latter appearance is due to the fact that during this period the multiplication of cells proceeds with especial activity at the upper lip of the anus of Rusconi at the point where the upper layer passes into the lower.

Since during this period—it may be some hours earlier, though usually later—many highly interesting processes take place in the ovum, we will now consider these more closely.

THE FORMATION OF THE ALIMENTARY CANAL.

In earlier stages the anus of Rusconi took the shape of a broad pit which had arisen by invagination of the epiblast. I am speaking of an embryo which is at least some four-and-twenty hours younger than that represented in Scott's fig. 10, *a*. At that period we actually have a gastrula before us. In a few hours, however, the number of the yolk-spheres lying at the bottom of the ovum has considerably increased. The diminution in the size of Baer's cavity during this time is not to be ascribed to the fact that the cells are thrust into it by the formation of the enteric cleft, but to the increase in the number of these cells.

The formation of the enteric cavity proceeds by a splitting off of the vitelline elements from the undifferentiated cells, which become the hypoblast (" von dem Drüsenkeim "), starting from Rusconi's pit, precisely as this process has often been observed and described in the frog, axolotl, and sterlet. In the animals just mentioned this process is easier to observe, because the cells which adjoin the cleft contain pigment-granules during their division and separation from the remainder of the yolk. In some cases a streak of pigment precedes the cleft. Since the ova of *Petromyzon* are entirely unpigmented, observation becomes somewhat more difficult. In spite of this we can convince ourselves by the examination of hundreds of preparations that the lower layer, the endoderm, arises by the separation of a series of cells from the yolk. It is further to be remarked that before the formation of the enteric cleft the sections already show a special grouping of the cells which are subsequently utilized as the elements of the lower layer. During this period and also somewhat later two layers, the ectoderm and endoderm, are present, which are separate from one another and continuous only at the point of flexure. The cells of the ectoderm are smaller than those of the endoderm, as is indeed perfectly natural, since the development of the former commenced earlier than that of the latter.

After this the chief centre of the developmental processes is situated for a time in the hinder portion of the embryo. In successful longitudinal sections, namely such as pass through the middle of the ovum from front to rear, so that they bisect the upper and lower lips of the anus of Rusconi, it can be seen that the embryo already extends over half of the ovum. It consists, as already stated, of ectoderm and endoderm, and each of these layers exhibits only a single series of cells throughout its entire extent. It is true that sections are to be found in which the ectoderm has more than one series of cells, but this is owing to the fact that the sections were taken obliquely and that the knife, working more on the surface of the ovum, has carried a larger strip of this with it. I have found preparations in which the enteric cleft communicated with the segmentation-cavity. The cells which were situated at the periphery of the cavity, immediately beneath the ectoderm, were utilized for the formation of the lower layer.

OVA 118 HOURS AFTER FERTILIZATION.

Ova belonging to this period exhibit but little difference from those of the preceding one. They have become somewhat longer; the two lips, the upper and the lower, and the plug which lies between them are still more distinct, and the embryo itself has still further increased in length. In many longitudinal sections each of the two layers continues to exhibit a single layer of cells. On the other hand, many transverse sections, if they have passed through the posterior end of the ovum, exhibit a multiplication of the ectoderm cells beneath the dorsal furrow. The spinal cord is in process of formation: as Calberla has already shown, this structure is at first solid, and it is not until later that the cells separate from one another and give rise to the spinal canal.

OVA 126 HOURS AFTER FERTILIZATION.

This is one of the most interesting periods. The embryo has become considerably longer. In very many transverse sections of the ovum the embryo is cut through in two places, at the anterior and posterior end. At the latter we observe the solid spinal cord, beneath which is the notochord already completely developed, and then the epithelium of the enteric canal, which forms its inner wall. On both sides of the notochord lie in part still solid rudiments of the protovertebræ, Wolffian ducts, and lateral plates; the latter pass into a single layer. A section taken through the anterior portion of the embryo presents another picture. At this point the central nervous system is thicker: a central canal has already developed at some distance from the brain, the anterior end of which is also still solid. At this region the notochord is not present, though the cells of the endoblast immediately adjoin the central nervous system. At some distance from the anterior end of the embryo the enteric cavity is of a very considerable size. It is surrounded above by a double layer of endoblast cells, which are somewhat thrust downwards in the middle by the spinal cord. On the other hand, on both sides of this depression, to the right and left of it, the endoblast forms an upward expansion of the cavity. If we now examine the sections in order from behind forwards, we observe two folds of the endoblast approaching nearer and nearer to the middle line. In this manner two cavities appear, the uppermost of which is the smaller. Finally the folds completely meet, forming a ring round the smaller cavity, which at last entirely disappears.

In the remainder of the body the formation of the notochord appears to take place by a simple constricting off of the endoblast cells lying beneath the spinal cord, as has already been described and figured by Calberla. On both sides of the notochord lies a double row of cells, which soon passes into a single one. These cells have separated from the endoblast. There is no space between the two rows; but in spite of this we already recognize the elements which will go to form protovertebræ, Wolffian ducts, and lateral plates. Moreover in many sections we find the protovertebræ already almost completely developed: the formation of a cavity in them takes place later on. The epiblast, too, during this period is still exclusively unilaminate except in the median line, where the spinal cord has already developed. In the sections it is still sometimes entirely separate from the ovum.

The development of all primitive organs is further advanced in the posterior than in the anterior portion of the embryo. The formation of the cavities and canals is effected either by the separation of the cells from one another or, as is especially the case in the region of the undifferentiated cells which become the hypoblast, by the consumption of the yolk-lamellæ, so that in the place of the yolk-cells only empty envelopes remain.

Development proceeds from the median line towards the sides. After the formation of the spinal cord and the notochord a cavity arises, first in the protovertebræ, which separate from the rest of the cells of the mesoblast, then in the Wolffian ducts, and finally in the lateral plates. It is asserted by A. Shipley (fig. 11) that the Wolffian ducts or the segmental organ develop before the protovertebræ. I have seen no evidence of this in my preparations. The figure in question is altogether too diagrammatic.

The protovertebral segments are not cubical, but are drawn out into a point at the lower inner angle towards the notochord.

On the Origin of the Sense-Organs.

I have not observed the formation of the auditory apparatus in embryos less than 160 hours old. There appears at the side of the brain a pit-shaped invagination of the ectoderm which is equally distinct in transverse as well as in longitudinal sections. The cells which are situated in the centre of the pit are somewhat longer than the remainder. After some time the pit closes and becomes a capsule, the future labyrinth of the auditory apparatus. At this period all cells, both of the skin as well as of the nervous system, are still pretty richly packed with yolk-lamellæ. The intermediate space between the auditory capsule and the brain is very inconsiderable, and subsequently almost completely disappears.

The formation of the eye takes place during the two hundredth to the two hundred and fortieth hour after fertilization. At the side of the upper surface of the fore brain, almost immediately behind the olfactory pit, we find a sac-shaped expansion of the cerebral wall. It extends backwards and downwards, and can be better seen in longitudinal sections, though in order to obtain a complete representation of it both classes of sections must be examined. At first the cavity of the saccule is exceedingly narrow, but it subsequently becomes somewhat wider, especially at its outer end.

The earliest rudiment of the paired eyes in the lamprey presents more similarity to the rudiment of the third eye in many animals than to that of the eyes of the Vertebrata in general. For in this case we find a relatively long tubular stalk, the outer and somewhat expanded end of which is only utilized for the formation of the retina. The outer wall of the eye-stalk grows thicker and becomes indented like a pit, just as the retina is generally developed. The epithelium of the skin, which lies opposite the rudiment of the eye, takes no part in its formation. During this time no trace of the lens can be discovered.

The formation of the nasal pit proceeds by a pit-shaped invagination of the outer layer, as has already been frequently described.

The whole of the earliest sense-organs appear to have arisen in the same manner throughout the entire Vertebrate phylum.

THE HEART.

I have observed the earliest rudiments of the heart, or, rather, of the venous vessel in embryos of the age of 133 hours. The longitudinal section taken from above downwards exhibits an arrangement somewhat similar to that figured by A. Goette in his well-known work on the development of the fire-bellied toad (fig. 37); for we observe that the enteric cavity has attained its greatest dimensions in the region of the head, which is in process of formation. Posteriorly towards the dorsal surface it becomes narrower and forms a very slight indentation in the middle of the undifferentiated hypoblast cells, and then proceeds as a sac-shaped depression in the yolk in the direction of the ventral surface. The walls both of the enteric cavity and of the venous sinus are clothed with cells of the endoblast, which as yet are far from having assumed an epithelial character. They are large and full of yolk-granules. At this period we have only the cavity of the vessel before us, which subsequently becomes constricted off from the intestine. The appearance of the rudiment of the venous system alters very little during the next forty or fifty hours.

In embryos of 180 hours the body has attained a considerable length. In longitudinal sections we observe the branchial cavity in the form of a long canal which already possesses gill-slits. Below the branchial cavity there appears, as in the previous stage, a depression passing off in a lateral direction from the intestine. It has in the meantime become somewhat longer and its lower end less regular. As a matter of fact it is continued in the shape of a cleft, which can be traced a very long way backwards, while rifts may be observed proceeding from it in all directions, which finally lose themselves between the yolk-spheres.

It is evident from what is here seen that long before the development of the heart we have a system of canals which are filled with a fluid—the lymph. In all the cavities mentioned, in the cavity of the intestine, the branchial chamber, &c. we find circular rings, a kind of membranes, which are probably remnants of yolk-spheres which have undergone dissolution. Isolated channels of this kind are to be met with in which some few yolk-granules are still present, while others are quite full of them. The granules are much smaller than the neighbouring cells or yolk-spheres of the undifferentiated hypoblast. We may consider that the yolk-spheres during the period which is now being described are on the average from nine to ten times larger than the granules alluded to: the size of many of them, however, is greater than this.

Further and more important changes, which already stand in direct connexion with the formation of the heart, are to be noted in embryos of from 200 to 220 hours, when they have attained a length of from 2 to 3 millim. Beneath the branchial cavity an expanded oval region is formed, just as if the embryo was somewhat swollen at this point. The longitudinal sections show that a wide cleft has here appeared in the lateral plates on the right and left: the outer layer applies itself to the skin, the inner one to the intestine. We then have on both sides of the intestine two oval vesicles, the greatest diameter of which lies in the vertical direction. The formations just described vividly remind us of the pleural sacs of the higher Vertebrates before the appearance of the lungs. In certain sections they appear quite empty; in others, taken higher up, we find the rudiments of the segmental organs, that is of the primitive kidneys.

In order to obtain a distinct representation of the development of the heart, we must have recourse to transverse sections. If we examine one of these from the cardiac region, we observe round the œsophagus a wide free space, which has been formed by the divergence of the two lateral plates: this is the body-cavity. We employ this term in order to apply a general idea to this cavity. The intestinal fibrillar plate (“ Darmfaserplatte ”), or splanchnic mesoblast, can be traced particularly well in stained sections. We observe a fold of it on the right, as also on the left side, which passes round the segmental organs and the upper half of the œsophagus. When the two layers meet beneath the closed œsophagus they assume a downward direction, and finally pass into the somatic mesoblast, which attaches itself to the ectoderm. At the spot at which the right and left fibrillar plates have approached one another—namely, where the two portions lying between the splanchnic and somatic mesoblast are opposite to one another —there is at first a narrow, and subsequently a much broader cleft, which extends from above downwards. This intermediate space is the cardiac cavity. The above-mentioned portions of the intestinal fibrillar plates had fused together at their upper and lower margins and become a closed tube, which now projects freely into the body-cavity and is attached to the intestine by a short band. Before the fusion of the median portion of the intestinal fibrillar plates to form the cardiac walls, there could already be observed on their inner margin a special layer of flat cells. This internal layer of cells separates from the external one; and in the transverse sections we have before us two tubes lying one within the other. The internal one becomes the endothelial coating of the heart—that is, the endocardium. The second, somewhat stouter tube becomes the muscular tissue of the heart, which on the outside is likewise clothed with endothelial cells. The heart in *Petromyzon* arises from the folds of the intestinal fibrillar plates, which alone furnish the material for all its constituent parts. I would especially point out that the elements of the intestine take no share whatever in the formation of the heart. A communication is established between the cardiac cavity and those lymph-chambers which we designated above as the commencement of the heart, and which have transformed themselves into the veins. At this period the veins have no walls of their own, and are in communication with many canals and lacunæ.

Though the literature of the subject will not be fully considered until my detailed and illustrated paper is printed, I cannot here refrain from mentioning that A. Shipley's observations with reference to the heart also are highly valuable. His figures (figs. 24 & 26) are faithful representations, albeit somewhat diagrammatic. At the time of the earliest formation of the heart the endothelium on the intestinal fibrillar plate cannot be seen with the distinctness with which it is shown in the figure.

Since the formation of the heart is one of the most difficult processes which embryology has to study, I would like to add a few more words to the results above described. According to an observation by P. Meyer, as communicated in his article " Ueber die Entwickelung des Herzens und der grossen Gefässstämme bei den Selachiern," the endocardium arises in a manner different from that which we have explained. This author states that when the intestine closes the two lateral veins apply themselves together beneath it, and unite into one vessel, to provide the heart with a single unpaired tube—an " endothelial saccule." The figures (Tab. 12. fig. 2, and others) which P. Meyer has given us entirely support his view; and in the embryology of the lamprey also we actually find a series of preparations which appear to confirm it. For it is an exceedingly striking fact that the endothelial saccule of the heart often lies at a great distance from the myocardium, as if it has arisen independently and has been in no way connected with the lateral plates. Moreover, we find the cardiac cavity bounded by the lateral plates, without its being possible to recognize distinctly the endothelium on their inner surface.

Then, too, preparations occur in which the lateral plates have not yet completely surrounded the lower surface of the intestine; their two layers lie close together and more towards the periphery, and yet in the middle of the body-cavity we find an endothelial pellicle belonging to the future endocardium. In spite of all these appearances I consider that I am bound to adhere to the opinion that the endocardium has separated off from the lateral plates on the inner surface precisely in the same manner as on the outer. I find myself compelled to do this by the arrangements presented by quite young stages of the embryos, measuring about 2·5 millim. in length. The endocardium is here visible in all sections taken in the cardiac region, but always in the closest connexion with the myocardium. Both membranes appear thick, and are richly provided with yolk-granules.

Before closing this division of my paper, I must not pass over in silence the statements of A. Goette, since they are at variance with my observations. According to this author, the endocardium is formed from endoderm. Since it is difficult to suppose that so capable an investigator as Goette should have been mistaken, the material investigated must have been of such a kind as to admit of what was seen being interpreted in a different fashion. Goette's view might be supported by the circumstance that in the neighbourhood of the rudiment of the heart the œsophagus is rather strongly compressed at the sides, and almost touches the ectoderm with its under surface. When the formation of the heart has taken place, the lumen of the œsophagus has diminished by one half. Isolated cells are then not infrequently to be found in the upper angle formed by the contact of the intestinal fibrillar plates. A constriction of the œsophagus, as has sometimes been described, or a splitting-off of a series of cells from its under surface for the benefit of the endocardium, I have never seen, and I therefore adhere to the assumption which I have stated above.

THE ENDOBLAST.

The branchial cavity arises by the separation of the cells of the yolk at the anterior end of the embryo, in the manner which we have had occasion to observe in the formation of the intestine. The great thick head, consisting of a compact mass of cells, commences to recede somewhat from the yolk, and becomes smaller and narrower. Between it and the yolk the anterior portion of the body of the embryo becomes continually more distinct and longer. The internal changes proceed hand in hand with the external ones. The cavity which has been formed, which was at first more spacious at the anterior end, gradually also extends backwards in similar dimensions. The entirely undifferentiated cells surrounding the cavity assume an epithelial character. In the canal which becomes the branchial cavity lateral evaginations appear, which extend from in front backwards. The evaginations become so pronounced that the endoderm cells come into contact with the epithelium of the integument, which is finally absorbed. Opposite the evagination a slight depression is sometimes noticeable. At certain spots it seemed to me that the epithelium of the future slit has thrust itself so far outwards that the cells of the epidermis here appear thinner. The groove which arises on the under surface of the branchial cavity, in the neighbourhood of the first to the fifth slit, and which subsequently becomes for the most part closed off—the thyroid gland—has been described very frequently, and I have nothing material to add. The main features of the formation of the mouth, the union of the ectodermal pouch with the endoderm of the branchial cavity, are likewise well understood. If we examine a few longitudinal sections, which were made parallel to the ventral surface of the embryo, pretty much such as those which are shown by A. Dohrn in his plate iv. (Bd. vii.), we are struck by the similarity between the gill-slits and the two outer angles of the oral pouch. It seems as though the latter are only the end of the series of those slits. The similarity appears not only in the position, but also in the form.

The liver is formed by evaginations of the intestinal wall. We observe that this is in connexion with canals, which soon become converted into tubes. At the spot at which these processes are taking place the intestine is less abundantly surrounded by yolk-cells than in its posterior division. At all events the yolk-cells take no part in the formation of the liver. In spite of Kupffer's statement that a neurenteric canal is not formed in the Lampreys, I must most emphatically insist upon its occurrence in these animals, though it is true that at present not a single satisfactory drawing of it exists.

If we follow the spinal cord in longitudinal sections, we see with the greatest distinctness how the end of it bends round the notochord, and then runs for a space beneath it, to end as a somewhat thinner cord in the upper wall of the end-gut above the anal opening. My preparations were stained with hæmatoxylin, and the cells of the spinal cord (as also the neurenteric canal) appeared very dark, in consequence of which they stood out from the rest. The cells were, moreover, much larger than others lying in the neighbourhood, such as, for instance, those of the epithelium. The shape of the canal in question is somewhat obscured, owing to the fact that a large venous vessel lies near it.

THE BRAIN AND THE GANGLIA.

In a provisional communication, which is not accompanied by figures, very little can be said as to these organs. Some days before the embryos are hatched the brain already possesses several divisions. During the formation of the optic vesicles the anterior wall of the fore brain is represented by a very thin lamella. The hemispheres and the olfactory lobes are developed afterwards. The hypophysis originates from the ectoblast, while in almost all other animals it is formed from the cells of the endoblast.

As to the epiphysis, I have made certain statements in the paper which has recently appeared on the third eye of the Lampreys. All ganglia (of the head, as also of the trunk) are produced from the cells of the ectoderm. The cerebral ganglia appear to arise at a very early stage. They subsequently separate from the epidermis, and appear to be related to the mesoblast. In embryos of from 2 to 3 millim. in length, however, we still find them in connexion with the integument. The spinal ganglia arise later on, and not above the spinal cord, but to the side of it. I have observed epithelial cells extending inwards from the skin like a plug between the protovertebræ. At a subsequent period they lay near the spinal cord, already separated from the skin, and forming a roundish independent group. From the spinal cord there proceeded a short fascicle of nerve-fibres—that is, a root—in the direction of the ganglion-cells. A junction between them was not as yet established.

In concluding this short communication I cannot refrain from mentioning that the description and figures by A. Dohrn of the cerebral ganglia (as, for instance, those of the trigeminus, ophthalmicus, facialis, vagus, and other nerves) are in the highest degree true to nature. I possess a large series of preparations, which show precisely the same picture as his figs. 1, 2, & 4 of pl. 10, and especially fig. 6 of pl. 11 (Bd. viii. Heft 2).

VI.—*Notes on* Apteryx Haastii.

By WALTER ROTHSCHILD.

MR. FORBES has expressed it as his opinion that *Apteryx Haastii* is a natural hybrid between *A. australis* and *A. Owenii*. I have paid much attention to this question as well as to the study of this genus generally, having had during the last four years over seventy living Kiwis of four species, and having examined some one hundred and sixty preserved specimens, of which over one hundred belong to my collection (in spirit, skins, and skeletons), belonging to five or, possibly, six species. More especially of *A. Haastii* I have at present:—

One adult male, alive.
One young male, alive.
Two adult males and four adult females, in skins.
Two young males, in skins.
Two chicks, in skins.
One adult female, stuffed.
Two adult males and two adult females, in spirits.
One chick, in spirits.
One adult male and one adult female, in skeletons.
One egg.

After an examination of these materials I am unable to agree with Mr. Forbes's views. A consideration of the geographical distribution of the various species of Kiwis must lead to a conclusion opposed to them.

Apteryx Mantelli.	North Island.
—— *Haastii.*	
—— *australis.*	South Island.
—— *Owenii.*	
—— *maximus*	Stewart's Island.

As *A. Haastii* occurs only in the North Island, where *A. australis* and *A. Owenii* are not found, it is evident that it cannot be a hybrid between them. However, I must mention that on looking over my skins of *A. Owenii* I find that seven specimens from the west coast of the South Island are larger and darker than those from the east coast, and therefore that it is quite possible that this larger race of *A. Owenii* has been mistaken for the true *A. Haastii*. This latter is called "*Roa-Roa*" by the natives, and not Kiwi.

Apteryx Haastii is the largest species of the genus, a female in my possession being considerably larger than the largest known female of *A. maximus*. It is further distinguished by its enormous beak, which, though not so long as that of *A. maximus*, is very much stouter even than that of the recently discovered extinct species.

As far as I can see at present another distinctive character will be found in the cæcum, which seems to differ not only in the two sexes, but also in the various species of the genus.

VII.—*Some Observations on the Mouth-organs of Diptera.*

By Charles O. Waterhouse.

Some two years ago I had occasion to study the mouth-parts of Diptera, and among other books consulted Prof. Lowne's work on the Blow-fly. In his first edition of this book, Prof. Lowne put forward the theory that the proboscis of the Blow-fly is chiefly composed of the maxillæ, and not of the labium as usually supposed, and in his new edition he keeps to this view. Prof. Lowne has arrived at this conclusion from studying the development of the parts in the embryo &c.

Prof. Lowne says: "So far as I know there is no dipterous or hemipterous insect in which there are any traces of mandibles, and the parts so named are always a part of the maxillæ, and articulate with the palpigerous scale" (New Edition, p. 151). The species in which I found the parts of the mouth most perfectly developed is *Pangonia longirostris*, and with this insect in view it is impossible for me to doubt that the larger pair of lancets are really the mandibles, and that in spite of the care and skill which Prof. Lowne brings to bear on his investigations, he has nevertheless fallen into some error. Prof. Lowne says: "the only reason for regarding the terminal portion of the proboscis as a modified labium is its position, and this is no evidence from a morphological point of view" (p. 129). This is true, but, so far as I am concerned, it is certainly not position *only* that influences me in my determination. With Prof. Lowne and others I consider the slender pair of lancets in *Pangonia* to be the maxillæ; this is clear enough from the presence of the maxillary palpi. The larger pair I consider to be the mandibles, not *only* on account of their position (although this is just what it ought to be), but because they appear to have a distinct origin from the more slender pair, and the structure of the base with its produced basal angles is only a slight modification of the form constantly met with at the base of the mandible. I would especially compare it with the mandible of the Australian Neuropterous insect *Bittacus*.

It is somewhat difficult to understand exactly what Prof. Lowne does consider these larger lancets. He speaks of them as "parts of the maxillæ" without saying what part. If they are parts of the maxillæ, I presume they are either the laciniæ or galeæ.

This, however, does not seem to be Prof. Lowne's view, for in speaking of *Pulex* he says, the pseudolabium is "formed by the united galeæ of the maxilla" (p. 152); and if the "pseudolabium" of the flea represents the galeæ, then the pseudolabium of the Diptera is formed in the same way, and yet we have still four lancets in many Diptera to account for!

If, however, these lancets are the mandibles and maxillæ, then the sheath of the proboscis would be the labium; and, apart from its position, it is frequently divided into three portions, very suggestive of the mentum, ligula, and paraglossæ.

I hope Prof. Lowne will some day give us a clearer idea of what he considers these "parts of the maxillæ" to be.

When speaking of the mouth-parts of the flea, Prof. Lowne incidentally mentions that the antenna in that insect is behind the eye, which, he says, "is a clear indication that the simple eye in the Fleas is not homologous with the great compound eyes of insects, which are never in front of the antennæ" (p. 152). When I read this sentence I could not help thinking of Prof. Lowne's statement above quoted (p. 129) that position is no evidence; and when one sees how completely the relative position of the eye, ocellus, and antenna change in such insects as *Tryxalis* and *Fulgora* for instance, I scarcely think it a convincing argument to say that the eye of the flea cannot represent the compound eye of other insects, simply because it is in front of the antenna. A trifle more and the antenna of *Fulgora* would be behind the eye.

VIII.—*Description of a new Baboon from East Africa.*

By Oldfield Thomas.

Among some Mammals obtained by Mr. F. J. Jackson in East Africa is a fine male Baboon evidently allied to the Abyssinian *Papio* * *thoth*, Ogilb. (with which I presume *P. doguera*, Pucheran, is synonymous), but so different from it in the character and colouring of its fur that I think it ought to be separated from it at least as a subspecies, for which I propose the term

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* I am entirely unable to follow those naturalists who, in deliberate defiance of the laws of priority, use *Cynocephalus* instead of *Papio* for the Baboons. Even on the inadmissible but oft-quoted score of convenience, it is surely a greater nuisance and source of confusion that some naturalists or curators of large museums (*e. g.* the Leyden) should use *Papio* and others *Cynocephalus*, than that those who are (and know they are) wrong in using the latter should give it up once for all, and learn the name which has an unquestionable claim to adoption.

Papio thoth ibeanus, subsp. n.

Fur remarkably coarse and shaggy all over the body, and even longer than in *P. t. typicus.* Colour a coarse mixture of blackish and dull fawny white, without any of the brighter yellow always present in the typical form, at least on the head and limbs. Hairs on the crown of the head broadly annulated with black, this part being nearly uniform yellow in the true *thoth.* Colour of outer side of limbs quite like back, the hairs slaty grey basally, ringed terminally with black and dull fawny white. Chin and throat well-haired, whitish, at first, anteriorly, unannulated, but gradually proceeding backwards blackish rings make their appearance, and on the chest all the hairs are broadly annulated with black and white and on the belly with black and dull fawn. Inner sides of fore limbs like chest, but inner sides of hind ones a clearer and less annulated fawn-colour. Upper surfaces of both hands and feet like the outer surfaces of arms and legs, not getting darker terminally.

Skull.—Owing to the fact that the typical and only available adult male skull of *P. thoth* is obviously deteriorated by captivity, it would be useless to enter into a detailed comparison between the two skulls; but, comparing the East-African skull with a fine Angolan skull of what I take to be *P. anubis*, it is characterized by its much less salient facial ridges, shorter and broader palate, markedly smaller and narrower foramen magnum, and higher and more vertically directed mandibular coronoid processes.

Dimensions of the type (an adult male skin):—

Head and body (c.) 850 millim.; tail (c.) 610; hind foot 182.

Skull: basal length 151; greatest length, exclusive of occipital crest, 195; greatest breadth 114; gnathion to lower edge of orbit 111; nasals, length mesially 64, laterally 68, greatest breadth 15; height of orbit 25·5; breadth across orbits outside at fronto-malar sutures 84; nasion to occiput, exclusive of crest, 99; palate, length 97, breadth between outer sides of $\underline{\text{m. 2}}$ 56·5, between inner sides of $\underline{\text{m. 2}}$ 33; combined lengths of upper true molars 37.

Hab. Lamu, East Africa.

Of other species of the genus besides *P. thoth* none of the present group are known from East Africa at all, *P. porcarius* being South African and *P. anubis* and *P. sphinx* being West African.

IX.—*On a new* Cephalolophus *from Mount Kilima-njaro.*

By Oldfield Thomas.

Mr. F. J. Jackson has presented to the British Museum the head of a *Cephalolophus* obtained by him some years ago on or near Mount Kilima-njaro. This head is clearly that of the animal doubtfully determined as *C. nigrifrons** in Mr. F. W. True's excellent account of Dr. Abbott's Kilima-njaro collection, and is also, I believe, specifically identical with a skin obtained many years ago by Sir John Kirk at Malindi, and, owing to its having lost the fur of its face, erroneously referred by me to *C. natalensis*, Sm., in my recent monograph of the genus †.

At Mr. Jackson's suggestion I propose to name the species in honour of Sir Robert Harvey, who was the first of their party to shoot a specimen of this interesting species; and taking first as my type the Kilima-njaro head only, it may be briefly diagnosed as follows:—

Cephalolophus Harveyi, sp. n.

Colour of face and nape as in *C. nigrifrons*, *i. e.* ground-colour chestnut, with a black blaze extending from the nasals to the occiput, expanding on the forehead; of cheeks, sides of neck, and throat pale bay, and of chin white, as in *C. natalensis*. Horns of male conical, very thick at the base, their greatest basal diameter going barely two and a half times in their length.

Dimensions of head:—Muzzle to eye 95 millim.; to occiput 188; ear above crown 70; horns, length 79, greatest basal circumference 77. The dimensions given by Mr. True may also be referred to.

Hab. Mount Kilima-njaro.

But if, as I see no reason to doubt, the Malindi skin and skull are also referable to this species, the following points of difference from *C. nigrifrons* may also be noted:—

General colour much paler, almost exactly as in *C. natalensis*; under surface decidedly paler than upper; feet slenderer and more delicate throughout; hoofs not elongated ‡

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* Proc. U. S. Nat. Mus. xv. p. 476 (1892).

† P. Z. S. 1892, p. 419. Owing to this specimen proving not to be *C. natalensis*, it will be necessary in the account (*l. c.*) of that species to delete all references to the male, including description of male horns and measurements of skull, these being all based on this Malindi specimen.

‡ It is probable that the true *C. nigrifrons* is an inhabitant of swamps and marshes, as its hoofs are so very markedly elongated as compared to those of its congeners. The measurement above given is between 30 and 35 millim. in the type specimen.

(greatest length of ridge of hoofs above, both fore and hind, about 20 millim.).

Skull, as compared with an equally fully adult male skull of *C. nigrifrons*, that of the type, rougher and more swollen in the frontal region; muzzle shorter and more conical, broader across the posterior ends of the nasals; parietal region longer; orbit smaller and more exactly circular; median notch of palate but little surpassing the lateral ones; bullæ decidedly smaller. As to skull-dimensions, those given in my monograph as those of "*C. natalensis* (♂)" (really this Malindi skull of *C. Harveyi*) may be compared with those of the *C. nigrifrons* on the page following.

This new species may be inserted in the synopsis of species in the above-quoted monograph (p. 415) as follows:—

a^{4}. Darker markings shining black or brown.

  a^{5}. Back uniform rufous, no dorsal stripe.

    a^{6}. Ground-colour dark chestnut above and below; hoofs elongated .... 5. *C. nigrifrons*, Gr.

    b^{6}. Ground-colour pale bay, lighter below; chin white; hoofs not elongated .... 5 A. *C. Harveyi*, Thos.

  b^{5}. Back with a black dorsal stripe, &c.

X.—*On the Mexican Representative of* Sciurus Aberti.

By OLDFIELD THOMAS.

IN 1882 * two squirrels sent from Durango, Central Mexico, by Mr. A. Forrer were referred by me to *Sciurus Aberti*, Woodh., a species previously only known from Colorado, Arizona, and New Mexico, and which I presumed to extend southwards down the high lands of the Sierra Madre as far as the point at which Mr. Forrer found it. Some doubt has been recently thrown on this determination, and I have therefore now made a renewed examination of Mr. Forrer's beautiful skins. This examination leads me to the conclusion that, although the identity of the Durango animals with *S. Aberti* should still be maintained so far as regards the species, using this word in the larger sense to which English zoologists are accustomed, yet there is sufficient difference in their detailed coloration to necessitate their being considered as belonging

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* P. Z. S. 1882, p. 372.

to a distinct subspecies. That modern American zoologists would probably separate this local form as a distinct species I am quite aware; but such a procedure would, as in other cases, have the great disadvantage of suppressing all signs of the evident relationship existing between the two forms, without gaining any greater local exactness than may be obtained by the free use of trinomial nomenclature.

Sciurus Aberti durangi, subsp. n.

Size and general characters of *S. A. typicus* *. Sides of nose from muzzle to eye rufous, as opposed to the "grey cheeks" of *typicus*; a ring round eye paler rufous. Ears entirely without tufts (type killed in middle of October); no chestnut or rufous spots round or behind their bases. Hairs of chest and belly slaty grey basally, as compared to "pure white" in *typicus*. Whole under surface of tail inwards of the submarginal black band coarsely grizzled grey, each hair being broadly banded with black and white; in *typicus* the under surface of the tail is "wholly white." Median part of dorsal surface of metatarsus dark-coloured, proximally like the lower leg, terminally with a rufous tinge; inner side of metatarsus and tops of toes white. Descriptions of *typicus* simply say "feet white."

Hab. Ciudad, Durango, Central Mexico; alt. 8100 feet, on the Sierra Madre.

Type B. M. 82. 3. 20. 16. Female, killed Oct. 14, 1881; a second specimen killed Aug. 7. Coll. A. Forrer.

XI.—*Note on the History of the so-called Family* Teichonidæ.

By Arthur Dendy, D.Sc., F.L.S., Melbourne University.

In reply to my note on "The Discovery of the True Nature of the so-called Family Teichonidæ," published in the 'Zoologischer Anzeiger' (no. 395), Dr. R. von Lendenfeld, in no. 402 of the same journal, endeavours to prove that he

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* It appears to me equally simple and exact, while far more euphonious, to use the word *typicus* for the typical subspecies, instead of doubling the specific name, as is commonly done. The original author's name should of course be appended after *typicus*. The ugly sound of a double specific name is always bad enough; but if that method is adhered to, we may in some cases have to employ *three* repetitions of the same word, *e. g. Lutra lutra lutra*, Linn., instead of (if like generic and specific are admitted) *Lutra lutra typica*, L., or, most euphonious of all, *Lutra vulgaris typica*, Erxl. This possibility of a treble repetition may well make us hesitate before insisting on the same word being used for both species and typical subspecies

arrived at his results quite independently of my work, and refuses to recognize that I have any claim to priority in the matter.

He bases his defence upon a preliminary communication entitled "Das System der Kalkschwämme," which he informs us that he read before the Vienna Academy on the 8th of January 1891, and which he accuses me of wilfully ignoring, although, as a matter of fact, I have never seen the paper in question up to the present moment.

My principal work on the "Teichonidæ" was published in January 1891, though written in Australia many months previously; hence, of course, it is possible that Dr. von Lendenfeld may not have seen it before he wrote his preliminary account, though that can be no excuse for not referring to it in his complete work ('Die Spongien der Adria'), which is not even dated till April 1891, and not published till the following December.

It is evident from Dr. von Lendenfeld's writings that he has never personally studied the group of sponges whose true nature he claims to have independently arrived at, and hence to an outsider it is difficult to see what could have induced him so suddenly to abandon the family "Teichonidæ" and adopt my views as to the relationships of the sponges comprised therein.

I would therefore like to point out, for the benefit of those who might otherwise be misled by Dr. von Lendenfeld's statements:—(1) That on November 14th, 1889, I communicated a paper on "The Pseudogastrula-stage in the Development of Calcareous Sponges" to the Royal Society of Victoria; (2) that in this paper I gave a preliminary account of the results of my researches on the anatomy of "*Teichonella labyrinthica*" and "*T. prolifera*," stating distinctly that "*T. labyrinthica*" is a true Sycon and "*T. prolifera*" a typical Leucon; and (3) that I sent a copy of this paper to Dr. von Lendenfeld.

In short, my main conclusions as to the structure and relationships of the "Teichonidæ" (with the exception of "*Eilhardia Schulzei*," concerning which we both owe our anatomical information to Poléjaeff) were published and received in Europe many months before the date on which Dr. von Lendenfeld says he read the preliminary paper on which he bases his remarkable claim to independent discovery.

As I have pointed out previously, Mr. Carter himself was the first to show that "*Teichonella labyrinthica*" is a true Sycon; but this statement of his had passed quite unnoticed, and no correct account of the anatomy of the sponge in question had appeared until the publication of my work.

I am aware that in his "Monograph of the Australian Sponges" (Proc. Linn. Soc. N. S. W. vol. ix. p. 1140) Dr. von Lendenfeld accepted the "family" with some hesitation. He says, "I have not seen any representatives of this family myself, but am of opinion that they might perhaps be considered as colonies of Leucones or Sycones, as Marshall asserted before Poléjaeff's essay was published." He also says of "*Teichonella labyrinthica*" (*loc. cit.* p. 1142), "The anatomy of this sponge is totally unknown, so that its name and position here are only preliminary." How near Marshall's opinion came to the truth of the matter spongologists will be able to judge for themselves. Since the publication of the above remarks Dr. von Lendenfeld has repeatedly maintained the "family Teichonidæ," and continued to do so until the very year in which my preliminary results were published. In other words, from 1885 till 1890 Dr. von Lendenfeld stuck to the family; then, when the outcome of my researches on "*T. labyrinthica*" and "*T. prolifera*" had been published and sent to him, he suddenly dropped the "family" and adopted my views without giving any reasons for so doing. Surely it is taxing our credulity too much to ask us to believe that he arrived at his results independently!

Melbourne,
November 8, 1892.

XII.—*Description of a new Species of the Cicadan Genus* Pœcilopsaltria. By W. L. Distant.

The very beautiful species here described was obtained by Herrn P. Frey at Nossi-Bé, an island near the north-west coast of Madagascar. Dr. Karl Brancsik, who has already commenced to publish the results of this expedition ('Jahreshefte des naturw. Vereines des Trencsiner Comitates,' 1890–91, xiii. u. xiv. Jahrg.), has submitted a specimen to me for identification, which proves to be a perfectly new species.

Pœcilopsaltria Brancsiki, sp. n.

♀. Head and thorax above ochraceous, the lateral and posterior margins of the pronotum greenish ochraceous. Head with a cruciform spot at centre of front and a spot at each basal angle of same, a broken transverse fascia between the eyes, and a spot near anterior angles of vertex black. Pronotum with two central lineate black spots, a similarly coloured semicircular spot at centre of basal margin, and the incisures blackish. Mesonotum with two tooth-like spots at centre of anterior margin, followed by a smaller spot on each side, a slender broken lateral fascia, and a spot near each anterior angle of the cruciform elevation black. Abdomen above castaneous, shaded with black, and greyishly pilose. Abdomen beneath and legs ochraceous; a broad subapical annulation to anterior femora, the anterior and intermediate tarsi, and the bases and apices of the tibiæ black.

Tegmina pale greenish opaque for more than half their length, remaining area obscure hyaline where the venation is fuscous; the transverse veins at the bases of the second, third, fifth, seventh, and eighth apical areas are narrowly infuscated; two small fuscous spots in upper ulnar area, some narrow and obscure discal fuscous markings and a series of small fuscous spots near the apices of the longitudinal veins to the apical areas. Wings pale greenish, with the venation and almost the basal half blackish.

The width of the head, including the outer margins of the eyes, is a little more than that of the base of the mesonotum; the lateral angles of the pronotum are broadly and angularly produced.

Long. ♀ 41 millim.; exp. tegm. 115 millim.

Hab. Nossi-Bé Island.

XIII.—*Notes on Two Genera of* Coreidæ *found in Madagascar.*

By W. L. Distant.

In the last published part of the 'Revue d'Entomologie,' tome xi. p. 264, Dr. Bergroth has continued his criticisms on the writings of his colleagues who study the order Rhynchota. Much of this criticism is valuable, some unfortunately is misleading; for excessive criticism is as open to error as is too prolific description. Amongst other proposed corrections is the statement that my genus *Parabrachytes* "est identique au genre *Odontorrhopala* *, Stål." I should be very glad to adopt this opinion of Dr. Bergroth but for the following distinctive characters, which he strangely appears to have quite overlooked or forgotten when he wrote: "Les seules différences sont offertes par les antennes . . . . et par le rostre."

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* Dr. Bergroth has altered the spelling of this generic name; as proposed by Stål it was "*Odontorhopala.*"

Odontorhopala.	*Parabrachytes.*
Pronotum with the lateral angles produced in foliaceous lobes.	Pronotum with the lateral angles moderately prominent and angularly rounded.
Abdomen strongly and abruptly dilated, especially at the fourth segment in both sexes.	Abdomen moderately and regularly dilated in both sexes.
First joint of the antennæ longer than the second.	First joint of the antennæ shorter than or subequal in length to the second.

Other points of difference, but of a minor nature, are to be found in the structure of the incrassated apices to the second joint of the antennæ.

I am now able to add the description of what appears to be a second species to the genus *Odontorhopala*.

Odontorhopala Bergrothi, sp. n.

♂. Allied to *O. callosa*, Stål, but differing from the description of that species by the following characters:—The clavus is not black, but concolorous with the corium; the second joint of the antennæ is not black, but is ochraceous, with the apical incrassated portion only black, and the sixth as well as the fifth segment of the abdomen is outwardly toothed.

Other characters not mentioned by Stål are as follows:—The pronotum, clavus, and corium are not only coarsely punctate, many of the punctures being black, but the lateral expanded angles of the pronotum are ornamented with small black tubercles on their upper surface which are continued in a more obsolete manner across the disk. The spinous tubercles to the femora and first joint of the antennæ are pale greyish in hue.

Long. 20 millim.; max abd. exp. 10 millim.; exp. pronot. angl. 10 millim.

Hab. Madagascar, Fianarantsoa.

XIV.—*On the Physiology of the Rattle of* Crotalus durissus.

By A. E. FEOKTISTOW, M.D.*

IN June 1887 I received ten living specimens of *Crotalus durissus*, which I have since been able to observe closely. Owing to want of a sufficient quantity of suitable food (the

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* Translated from the 'Mélanges Biologiques tirés du Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg,' t. xiii. livraison 1, pp. 1–4: St. Pétersbourg, 1891.

animals refused to eat anything but very young rabbits), I lost five of them in the course of the first six months. The remainder are in good condition, and now (August 1888) devour birds in addition to rabbits. They live in a large den, provided with a cement floor and a spacious water-tank, and permanently warmed by hot water, which renders it possible to maintain the temperature of the air in the interior at 77° to 81°·5 F. (20° to 22° R.). The snakes are provided with living food in sufficient abundance, and are equally lively in winter and summer.

This opportunity has enabled me to make accurate observations upon the growth, shedding, and renewal of the rattle. Up to the present nothing is known with certainty as to the physiology of this apparatus. Throughout America, for example, the inhabitants estimate the age of a Rattlesnake according to the number of rings in the rattle, and they believe that a new ring is added annually (Brehm). Others, again, consider that a new ring is formed at each ecdysis, and so on. Brehm * points out that though it is true that Rattlesnakes which have been kept in captivity and observed for several years consecutively have been found to increase in size, an increase in the number of the joints of their rattles has not been perceived; on the contrary, these remained unchanged for years. It is likewise not definitely stated by any author how long a rattle may become. I am in the happy position of having been able to make certain observations upon healthy specimens with good appetites, which decide these questions.

Five of my snakes shed their long rattles independently at different times, and I was now able especially to observe how rapidly these redevelop. I would first, however, remark that it is perfectly natural for the rattle of the Rattlesnake to fall off periodically or at irregular intervals. The organ in question consists of dead horny tissue, which is developed into the well-known hollow "cones": while these cones partly enclose one another, to form the rattle, they are yet only somewhat loosely connected together. Now it may be readily understood that such a chain of cones, when it attains a certain length, is greatly exposed to mechanical shocks, and consequently may easily break off. Without any injury to the snake itself, this chain may be also cut off or torn off by force. This is indeed the simple reason why the rattle never becomes particularly long, and rattles with from fifteen to

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* Brehm, 'Thierleben,' Bd. vii., "Kriechthiere,' 1883, p. 491.

eighteen joints are rare [*]. As a rule, the rattle only lasts long enough to become eight- or nine-jointed.

When a rattle has fallen off, its last-formed joint (consequently the first, counting from the base) at least is always left behind on the tail; for it is firmly united with the latter, until it is replaced by a new one forming underneath it. This last-formed joint of the rattle has not the dusky-brown colour of the older joints. It is rather of a horn-like transparency, and only of a faintly yellowish tint. Showing most distinctly through the thin walls of this joint of the rattle, we see the horn-producing cone at the end of the tail as a white, flattened, irregularly conical mass, with a deeply indented tip.

As I have already stated, I was able to follow the reproduction of the rattles in the case of five of the Rattlesnakes, which had shed these organs. So long as their rattles remained short, the snakes were naturally also unable to make a noise. But the joints were gradually replaced, and in such a way that in all cases in the course of from three to four months two new ones were already present, in addition to the joint already mentioned, which was left behind, and which was now terminal in position. Three-jointed rattles like these produced a fairly loud sound. In the course of a year the rattles developed into chains with from five to six joints, and were then capable of producing the usual very intense rattling sound. The reproduction of the rattles had nothing in common with the ecdyses [†]. It is well known that the epidermis is shed without the rattle, separating close to the margin of the latter, and, indeed, in such a way that the end of the tail in the cast skin is represented by an aperture with finely notched edges corresponding to the rows of scales.

It consequently follows from my observations that a joint of the rattle can be produced in the course of every two to three months [‡], and I do not understand why other observers have not noticed the growth of the rattle in captive Rattle-

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[*] Rattles of forty-two joints, as figured by Seba, surely exist only in the imagination!

[†] Schlegel (' Essai sur la physionomie des serpens,' t. ii. 1837, p. 557) thought that a new joint of the rattle is formed at each ecdysis. This opinion has recently been expressed by Garman also. According to my observations, however, the ecdyses succeed one another much more rapidly (an ecdysis every six weeks) than the formation of the joints of the rattle.

[‡] This assertion of course implies the provision of artificial warmth during autumn, winter, and spring. In the natural state the growth of the rattle evidently proceeds much more slowly.

snakes. Probably the snakes were kept under conditions unfavourable for their welfare, whereby the vital processes were checked. Perhaps, too, the observations were not conducted with sufficient care.

As regards the actual rattling, I can in general confirm the words of Geyer: if the Rattlesnake is crawling slowly along, it draws its rattle after it quite quietly along the ground; if, however, it is endeavouring to escape, it raises the rattle at an angle of about 60°, and at the same time rattles continuously. When the snake is in pursuit of its prey, nothing is usually to be heard of it. This is not always the case, however; on the contrary, I often saw Rattlesnakes pursuing the rabbits which served them for food and making a loud rattling, whereat, however, the latter showed no fear at all. When irritated the Rattlesnake assumes the threatening attitude which is admirably represented in Brehm's 'Kriechthiere' (p. 492), and is at the same time capable of rattling literally *for hours and continuously.* The noise which it thus produces can be with difficulty compared with any other; in any case it only very distantly resembles the "chirping of a grasshopper," as is asserted by Brehm. A large powerful Rattlesnake makes so loud a noise with its rattle that it is impossible to understand the words of a person speaking in a loud tone at a distance of three paces when the snake's cage happens to be between the individuals conversing. The powerless specimens which we usually see in zoological gardens give no idea of this. If the vibrating rattle dips into water, a peculiar sound arises which completely resembles the hissing of red-hot iron when it is plunged into water. Beneath the water the rattling is almost noiseless. If a Rattlesnake is held with one hand behind the head, while the other hand grasps the end of the tail just behind the rattle, it becomes impossible for it to make a noise.

I have attempted to determine the number of vibrations which the rattle makes per minute. A large Rattlesnake was grasped by the neck, while an assistant thrust a needle through the middle joint of its seven-jointed rattle in such a way that it pierced the rattle in its greatest diameter—consequently from above downwards, if we imagine the snake lying quiet with its tail outstretched upon the ground. Now, since the rattle (in the position in which we have supposed the snake to be) is, in making a noise, moved from left to right and back again, the needle was able to trace curves of vibration upon paper blackened with soot. As a registering apparatus I used Dudgeon's polygraph, with a strip of blackened paper which was made to slide rapidly forward by means of the clockwork. The tail of the snake was to a certain extent fixed by my holding the snake with my hand in the region in front of the anus. After much trouble I succeeded in bringing the needle in a suitable manner into contact with the strip of paper, and in obtaining curves of vibration, from which the number of the vibrations per minute (the rapidity of the progression of the strip of paper being known) could be calculated with a fair degree of accuracy. In this manner it was found that the movements of the rattle are composed of great vibrations of the entire tail itself and of smaller vibrations of the actual rattle, in such a way that the tail makes seventy-five and the rattle, on the other hand, one hundred and ten vibrations per minute. These are approximate average numbers, since I was able to obtain only faulty curves, because the rattle does not perform its vibrations precisely in one plane. Movements kept up for hours with rapidity like this are absolutely amazing. When observed with the naked eye, only a blurred image is seen of the rattle moving at this rate *.

BIBLIOGRAPHICAL NOTICES.

Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum.—Part I. *Sphinges and Bombyces.* By Col. C. Swinhoe, F.L.S. &c. Oxford: Clarendon Press, 1892.

For the production of this volume and the arrangement of the moths in the Oxford Museum so that they have become available for useful study we are indebted to the entomological zeal of Col. Swinhoe, his many years of study of the moths of the Indian region having rendered him well fitted for the work he has volunteered to do and so ably begun, a fact evidently appreciated by the University of Oxford, as testified by the honorary degree they have just conferred on him.

The volume includes all the Sphinges and Bombyces from the Oriental and Australian regions in the collection of the late W. W. Saunders, which was acquired by Prof. Westwood for the Oxford

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* The following authors have written upon the structure of the rattle:—Lacépède, 'Histoire des Serpens,' vol. ii. pp. 390–420, pl. xvii., 1789; Leuckart, 'Anatom.-physiologische Uebersicht des Thierreiches,' 1855; Czermak, "Ueber den schallerzeugenden Apparat von *Crotalus*," Zeitschr. f. wiss. Zoologie, Bd. viii. pp. 294 et seqq., 1857; Wymann, "The Mode of Formation of the Rattle of the Rattlesnake," Proceedings of the Boston Society of Natural History, vol. viii. p. 121, 1861–62; Garman, "The Rattle of the Rattlesnake," Bulletin of the Museum of Comparative Zoology at Harvard College, vol. xiii. No. 10, 1888.

Museum about the year 1877; and it is a matter for the greatest regret that the species from America and Africa, which would not have swelled the volume to any great extent, could not have been included at the same time, so as to make it complete in itself.

The collection was originally arranged and described, whilst still in Mr. Saunders's possession, by the late Francis Walker, his descriptions being published in the British Museum Catalogue which he was then engaged on; and here, as in all his other entomological work, he fully exhibited his well-known propensities towards describing the same species over and over again and placing them in the most incongruous families and genera, so as to render his description entirely unintelligible without inspection of his types.

In this state of chaos and almost entirely neglected by entomologists the collection has been left till Col. Swinhoe took it in hand little more than a year ago; and it has been his task to bring it to London bit by bit and compare it with Walker's types in the British Museum and with the types of later authors, so that the correct synonymy of the species might be arrived at; this has been most carefully done, and little is left to be desired in this direction.

The not less arduous task of reducing the species to their proper families and genera has also been ably carried out, though there are some species still out of place; thus *Balatæa* belongs to the Zygænidæ, not the Ægeriidæ, and *Bonia* probably to the Tinægeriidæ, whilst the affinities of the Epicopeinæ are with the Uraniidæ, not the Chalcosiinæ, and *Duga* belongs to the Geometridæ, not the Lithosiidæ. With regard to the genera, as much has been done as is well possible taking into consideration the state of utter confusion in which the genera of tropical Heterocera are at present involved, and many years must elapse before a comparative analysis of the whole can reduce them to order. The drawing of the neuration of new genera will be found useful, though that of one, *Chalioides*, is not very correct, and in another, *Platyzygæna*, the internal veins of the fore wing have been omitted: whilst the eight coloured plates will enable many of Walker's species to be identified. For the species the system has been adopted of describing the races from each different district or island as distinct, as indeed is usual, though we believe that in the near future this system will be entirely abandoned and all these slight races be reduced to the rank of subspecies; and not till this is done will it be possible to see at a glance the value of the names in any faunistic list or to deal with the vast numbers of insects in such a manner as to give a comprehensive and intelligible classification of the whole of them; then perhaps the 2,000,000 species, at which the number of existing insects has been estimated by several of the late presidents of the Entomological Society, may be reduced to some 400,000, or about double those at present known, which seems the only chance for systematists of avoiding a general migration to the lunatic asylums of the country! G. F. Hampson.

Fossil Plants as Tests of Climate. By A. C. Seward, M.A., F.G.S., &c. 8vo. 151 pages. C. J. Clay & Sons: London.

This is the "Sedgwick Prize-essay" for the year 1892, and its subject has been well chosen (1) as being worthy of, and indeed requiring an earnest and comprehensive study of both recent and fossil botany by the essayist, and (2) as a subject, a broad view of which, based on trustworthy details, is a desideratum with geologists.

As is due to observers in the past, though results of value were scanty even in the early part of the present century, careful references to early works, and critical notes on the facts and opinions therein stated, are given in the "historical sketch" (pages 1–32), which, like the Essay itself, is based on Mr. Lester F. Ward's 'Sketch of Palæobotany,' in the 'Fifth Annual Report of the U.S. Geol. Survey' for 1883–84, pages 363–453 (1885), and extended to the present time.

A general knowledge of the present distribution of plant-families, and of their relation to climatal conditions, must precede the consideration of the coexistence of the ancient and extinct floras with the successive geographical conditions of bygone lands and their changing climates; Chapters II. and III., therefore, comprise pertinent remarks by trustworthy authors treating of the distribution of plants, with reference to geography and topography, height of land above the sea-level, the nature of the soil, and, lastly, low temperatures, as in Greenland, Grinnell-land, Alaska, and Russian Lapland.

In Chapters IV. and V. the influence of external conditions upon the macroscopic and microscopic structures of plants is considered, on the basis of published reports with respect to the habit and size of plants in relation to climate; the form, position, and structure of leaves; their minute structure and its relation to external conditions; water-plants; acclimatization and naturalization; and minute anatomy of fossil plants; also the annual rings in recent and fossil plants.

"By far the most interesting lessons in questions of ancient climates have been taught by fossil plants in the high northern latitudes of the Arctic regions," hence Chapter VI. comprises the notices and remarks made by various observers on (1) the Devonian and Carboniferous plant-remains of Bear Island, Spitzbergen, and Melville Island. (2) Upper Carboniferous of Siberia, Novaya Zembla, and Spitzbergen. (3) Jurassic of Spitzbergen and Melville Island (?). (4) Cretaceous of Spitzbergen and Greenland. (5) Tertiary of Spitzbergen, Iceland, Greenland, Grinnell-land, Bathurst Island, Banks' Land, Prince-Patrick Island, and Mackenzie River. (6) Quaternary of Spitzbergen.

So far as the fossil plants of the Arctic regions have been studied O. Heer considered that they give no evidence of any difference in the temperature of the Polar Regions from that of Central Europe;

and it may be taken conclusively that no direct evidence is afforded in favour of the existence of climatal zones in Carboniferous and Jurassic times.

The Tertiary Arctic plants were regarded as Miocene by Heer; but J. S. Gardner has adduced reasons to prove that they show a passage from the Cretaceous to the Miocene, and that therefore they may claim to be Eocene.

The difficulty of regarding the plants of the old Coal-measures as definite indicators of climate is carefully dwelt upon. Their several structures and relative size cannot be taken without great caution as indications of a tropical climate, nor of the presence of an excess of carbonic acid in the air; nor indeed would a hot climate suit the peat-like decomposition of marsh-plants. Certainly the coal-plants had a very wide geographical distribution, favoured by (1) the absence of the highest plant-forms, and which would have been strong opponents in the struggle for existence; (2) their propagation by spores, being thereby widely disseminated. Nevertheless, there are important differences in the plant-remains of distinct coal-fields. Thus the Carboniferous flora of North America contains a large number of species not represented in that of Europe.

In Chapter VII. the climate and vegetation of the Carboniferous Period are reviewed according to evidences derived by geologists from its plant-remains found in different parts of the world. Those of the European and North-American Coal-measures are abundantly noticed in the foregoing chapters, as they take their places under the different structural or other relationships; and now (pp. 102, &c.) that the probable existence of different climatic zones or botanical provinces in the Coal-period has to be discussed, the Carboniferous (or Permo-Carboniferous) strata and plants of India, South-Africa, and Australia are taken in order. 1. The Lower Gondwána System in India, including the Panchet, Damuda, and the Talchir series. 2. The Karoo formation in South Africa, or rather the Ecca Beds lying just below it. 3. The Wianamatta, Hawkesbury, Newcastle, and Muree beds of New-South-Wales. 4. Queensland. 5. Tasmania. These several regions and their formations are tabulated (pp. 122, 123) after Feistmantel and Waagen, to show more particularly the horizons of 1. Glossopteris, 2. Glacial phenomena, and 3. Lepidodendron. The essayist is as cautious in giving an opinion in this case as in all the other points of discussion, but seems to accept the opinion expressed by Neumayr, Blanford, and Feistmantel that the Glossopteris flora came in with the cold climate indicated by the glacial conglomerates, and, replacing the older Carboniferous types, spread gradually towards the North, probably from a Southern Continent.

The recent valuable researches by Clement Reid and others on Pleistocene plants indicative of a cold climate in Britain, as some of Pliocene age witness low mean annual temperatures for Switzerland and elsewhere at that particular period, are referred to in Chapter VIII. Further accurate research is required to approach with certainty any conclusion as to climatal conditions in the several geological periods. Some indications have been offered in the course of the essay, as shown above. The Mesozoic floras in particular have yet to be carefully reviewed as tests of climate. Suggestive remarks on fossil Ferns and Conifers are then offered; and the Author says:—"We may expect that a closer study of the Geological floras, not only from phylogenetic and anatomical, but also from biological points of view may enable us to penetrate further into the life-conditions of those forests of which the Earth's crust affords us such numerous, though often too fragmentary, relics."

The list of works referred to in the text, occupying pages 134–146, well arranged and made serviceable with reference to the numerous footnotes, is a welcome bibliography for palæobotanists. The Essay has also a useful Index. Like other scientific works issuing from the University Press at Cambridge, this is well printed on good paper.

MISCELLANEOUS.

Comparative Researches upon the Organization of the Brain in the principal Groups of Arthropods. By M. H. Viallanes.

I have the honour of communicating to the Société de Biologie the principal results of researches which I have been conducting for several years upon the organization of the nervous system of Arthropods, and of which I have hitherto only published detached fragments, some in the 'Annales des Sciences Naturelles' and the rest in the 'Comptes Rendus de l'Académie des Sciences.'

Organization of the Brain of Insects.—In the Insects the brain is formed of three segments corresponding to the first three cephalic zonites. The first segment, or *protocerebron*, innervates the eyes; it is the seat of the visual perceptions, while the psychic centres also reside in it. The second segment, or *deutocerebron*, innervates the antennæ; it is the seat of the olfactory perceptions. The third segment, or *tritocerebron*, innervates the labrum and the initial portions of the digestive canal; in it is situated the centre of the gustatory sense.

Before entering further into detail as to the constitution of the cerebral segments, it may be mentioned that the first two are entirely preœsophageal, that is to say that the commissures which unite their symmetrical portions are situated in front of the œsophagus. In the case of the third segment the conditions are different; here all the commissural fibres pass behind the œsophagus, where they constitute the commissure known under the name of the *transverse commissure of the œsophageal ring.*

The protocerebron is composed of a pair of lateral masses termed optic ganglia and of an intermediate median mass. The constitution of the optic ganglia is most remarkable and most constant;

they are composed of a series of three ganglionic masses united to one another by decussating fibres. The median protocerebral mass is formed of a pair of lobes, which are intimately fused together and contain in their interior—(1) the pedunculate bodies, which are the seat of the psychic functions; (2) the central body, the organ whither fibres coming from all points of the brain converge; (3) the *pons* of the protocerebral lobes, a portion discovered by myself, the significance of which is as yet unknown.

The deutocerebron is composed of a dorsal portion, the structure of which has nothing particularly noteworthy about it, and of two olfactory lobes, which are highly differentiated in view of their special functions, and are characterized especially by the presence of organs known under the name of olfactory glomerules. The olfactory lobes, whence the sensory fibres of the antennary nerve originate, are united to the optic ganglia and to the pedunculate bodies by fibres which decussate in the median line; this connexion, which is absolutely constant, seems to be bound up with physiological necessities. Besides the antennary nerves, the deutocerebron gives origin to a pair of tegumentary nerves and to a pair of roots destined for the visceral nervous system.

The tritocerebron is represented in the Insect solely by a pair of ganglionic masses, which we will designate œsophageal ganglia: these are separated from the median line and united to one another behind the œsophagus by the transverse commissure of the œsophageal ring. Each of the œsophageal ganglia gives rise by means of a common trunk to a nerve, which is destined for the labrum, and to a root of the visceral nervous system.

In the Insects the visceral nervous system is composed—(1) of a series of three median ganglia, which are connected with one another, and of which the first, known by the name of the "frontal ganglion," is united to the œsophageal ganglia by a pair of roots, which are often double; (2) of a pair of lateral ganglia [*]. Each of these latter is connected, on the one hand, with one of the median ganglia, and on the other with the deutocerebron, by means of a nerve-root which has already been mentioned.

The brain of the Myriapods is precisely similar to that of the Insects in structure. But the visceral system of these animals exhibits a remarkable condition, for it preserves throughout the whole of life certain characters which in the Insect are only found in the course of embryonic development.

For our knowledge of the cerebral structure of *Peripatus* we are indebted to the researches of M. Saint-Rémy [†]; it is connected in the closest manner with that of Myriapods and Insects.

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[*] The lateral ganglia are generally each divided into two little masses, termed by M. Blanchard the ganglia of the vessels and tracheæ ("ganglions angien et trachéen").

[†] M. Saint-Rémy has published (Arch. Zool. exp. vol. iii. *bis*) a most conscientious paper upon the structure of the brain of Arachnids, Myriapods, and *Peripatus*; this has been of great assistance to me

The Brain of the Crustacea.—Like the Insects and the Myriapods, the Crustacea possess a brain formed of three segments—protocerebron, deutocerebron, and tritocerebron.

The protocerebron of the Crustacea is constructed upon the same plan as that of the Insects; we find in it an optic ganglion formed of the same portions, as well as pedunculate bodies, a central body, and a pons of the protocerebral lobes. In the same way their deutocerebron is in every respect similar to that of the Insects and the Myriapods.

In the Insects and the Myriapods the third cephalic zonite is devoid of appendages and only bears the labrum; in the Crustacea, on the contrary, the same zonite bears, in addition to the labrum, the second pair of antennæ. This difference entails a slight modification in the structure of the tritocerebron. While in the Insects and Myriapods the tritocerebron is represented only by a pair of œsophageal ganglia, in the Crustacea the same cerebral segment is formed by a pair of œsophageal ganglia, and, in addition, by a pair of antennary lobes intercalated between the latter and the deutocerebron.

The œsophageal ganglia in the Crustacea, as in the Insects and Myriapods, are united with one another behind the œsophagus by the transverse commissure of the œsophageal ring, and each of them gives rise, by means of a common trunk, to the nerve of the labrum and to a root of the visceral nervous system.

The antennary lobes, the commissural fibres of which pass with those of the œsophageal ganglia behind the œsophagus, give rise to the nerves of the second antennæ, to a pair of tegumentary nerves, and to the motor nerves of the eye-stalk.

The visceral nervous system of the higher Crustacea differs from that of the Insects in a single point, which is, however, of but slight importance. In the Crustacea the unpaired and the lateral ganglia, instead of being separated as in the Insects, are all fused into a median mass applied to the wall of the stomach, and known by the name of the *stomatogastric ganglion.* This mass is united to the brain by roots, which are strictly homologous with those which we find in the Insects. Like the frontal ganglion of the Insects, the stomatogastric ganglion of the Crustacea is united to the œsophageal ganglia by a pair of roots, which are generally double, and, like the lateral ganglia of the same animals, it is connected with the deutocerebron.

We therefore conclude, from what has been stated above, that, from the point of view of cerebral structure, there exists the closest relationship between the Crustacea, Insecta, Myriapoda, and *Peripatus.*

Limulus and the Arachnids, of which in other respects many zoologists recognize the affinities, constitute, as regards the organization of their brain, a most homogeneous group, but one which recedes considerably from the rest of the Arthropods.

In *Limulus* and the Arachnids the brain is composed of two segments only, the protocerebron and deutocerebron, both of which are provided with preœsophageal commissures. The protocerebron, which innervates the eyes, is comparable to the protocerebron of the Crustacea and Insects; it is nevertheless to be observed that in *Limulus* the pedunculate body attains truly colossal proportions. The same organ, although considerably modified, is still recognizable in the Arachnids, in which M. Saint-Rémy has described it under the name of the stratified organ ("*organe stratifié*").

In *Limulus* and the Arachnids the deutocerebron, instead of innervating olfactory antennæ, as in the Crustacea and Insects, performs the same function for the cheliceræ, which are simply tactile appendages, and so is not differentiated in view of special sensorial perceptions. The tritocerebron is wanting in *Limulus* and the Arachnids, and the first ganglionic mass which follows the deutocerebron is devoted exclusively to the innervation of the first maxillipede or mandible *.

The visceral nervous system of *Limulus* and the Arachnids is represented only by lateral ganglia, which, as in the case of the Insects, derive their roots from the deutocerebron; the median ganglia are wanting; the absence of these centres is evidently correlated to that of the tritocerebron.

Finally, we may express the differences and resemblances presented by the different types of Arthropods as regards the organization of the brain by dividing these animals into two great groups.

The first of these, comprising the Arachnida and *Limulus*, is characterized by the absence of the tritocerebron and the non-differentiation of the deutocerebron into an olfactory centre.

The second, which embraces the Crustacea, Insecta, Myriapoda, and *Peripatus*, is characterized by the presence of a tritocerebron and the differentiation of the deutocerebron into an olfactory centre.

This group may be itself subdivided into two sections, the first containing only the Crustacea, which are provided with two pairs of antennæ, the second embracing Myriapoda, Insecta, and *Peripatus*, which possess a single pair of antennæ.—*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, n. s., t. iv. (May 6, 1892), pp. 354–357.

On the Circulation of the Blood in young Spiders.

By M. Marcel Causard.

I have examined the circulation in young spiders belonging to fifteen genera of Dipneumones, of which the following twelve have been determined by M. Eugène Simon:—*Dictyna*, *Tentana*, *Theridion*, *Epeira*, *Zilla*, *Micariosoma*, *Chiracanthium*, *Textrix*, *Clotho*,

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* The rostrum of Arachnids is analogous to the labrum of Crustacea and Insects, but it belongs to the second zonite and is innervated by the deutocerebron.

Pardosa, *Phlegra*, *Heliophanus*. Three other genera examined came from eggs found under stones without the adult females.

My results differ in certain points from those obtained by Claparède for *Lycosa*. The ramifications of the aorta are indeed such as were observed by this author, but the recurrent branch arising from the cephalic arteries conducts the globules into a lacuna occupying the median portion of the upper face of the cephalothorax, and which is not, as was supposed, an actual gutter; the globules which circulate in it from the front towards the rear, returning from the ophthalmic lacunæ, form a sort of sheet spread out beneath the integument; then, overflowing at the sides without following any definite route, they unite with the currents which skirt the lateral portions of the cephalothorax. In the Saltigradæ, in which the latero-posterior eyes are very large and placed well behind the others, the globules which have circulated round these eyes arrive at the central lacuna by following real gutters. Between the median anterior eyes globules are observed to penetrate between these organs to gain the sternal face of the cephalothorax.

In young spiders which have already undergone the first ecdysis and are still transparent other ramifications of the cephalic arteries, not remarked by Claparède, may be observed in the cephalothorax. These canals, which communicate with the recurrent branch of the cephalic artery, of which mention has been made above, carry the globules back towards the posterior portion of the cephalothorax; at certain points of their course globules may even be observed as they rise from the depth of the organs. The arrangement of these canals is the same in all the genera studied, except in the Saltigradæ, where it is slightly different. The appearance of these ramifications, which do not exist immediately after the animal is hatched, is highly interesting, since it shows that if, in consequence of the exclusive study of young spiders, the arterial system of these creatures has been considered as being very slightly ramified, it is nevertheless susceptible of complication and of attaining in the adults the development which the researches of M. Blanchard, confirmed by those of M. Schneider, have demonstrated.

In the appendages the globules of the arterial current follow one another in narrow file. The venous current is broader and forms a sort of sheet beneath the integument on the extensor side; it may be temporarily subdivided by muscular masses.

In all the genera which I examined I found the sternal branches of the pedal arteries, which open into the transverse sternal lacunæ. In the median sternal lacuna the globules come from the deep parts chiefly through a sort of notch, corresponding to the interval between the second and third pairs of limbs. Of these globules some go towards the rear, and the rest towards the front, to empty themselves at last into the transverse lacunæ and rejoin the venous currents returning from the appendages upon the sides of the thorax.

It seems, moreover, that the route followed by the globules of the blood in the various cephalothoracic lacunæ may be slightly variable.

At the point where it divides to give off the pedal arteries each trunk of the aorta emits a short branch towards the sternal face; the two sanguineous currents thus formed encircle the sucking stomach, and, uniting forthwith, travel below the œsophagus and come into view beneath the integument, pouring numerous globules into the median sternal lacuna. This is probably the first of the anastomoses described by M. Schneider, that which gives off the *subœsophageal* vessel.

Though the abdomen is but slightly transparent the heart is generally quite visible, as also the two anterior pairs of its orifices (*pylocardia* of Schneider). The posterior pair is usually very difficult to observe. The blood which returns from the lungs into the pericardium enters the heart partly by the anterior and partly by the median orifices. In the posterior portion of the pericardium the globules circulate *from behind forwards*, to arrive at the median and posterior orifices. The blood which, penetrating into the anterior portion of the heart, is not sent into the aorta, circulates in this organ *from in front backwards*. I have nevertheless once seen in the anterior region of the heart the sanguineous current produced *from behind forwards*, because the greater portion of the blood returning from the lung gained the median instead of the anterior orifices of the heart.

I have not been able to directly observe globules issuing from the heart by the lateral arteries of M. Schneider; but in young specimens of *Heliophanus* I have succeeded in seeing in the posterior portion of the body a sanguineous current recede from the heart and branch off to lose itself in the liver. In young individuals of *Dictyna* and *Chiracanthium* I have perceived at the sides of the abdomen a current of globules proceeding towards the ventral face, which probably belonged to one of these arteries.

The blood which escapes from the posterior portion of the heart passes into the pygidial lacuna, which surrounds the anus and the spinnerets. It divides into two currents, which reach the ventral face; a few globules separate from the rest to circulate in the spinnerets before rejoining the common route. These two currents flow forwards, following the longitudinal ventral muscles, and mingle with those which have come from the cephalothorax, in the interval which separates the two lungs. The globules disappear behind the respiratory lamellæ, to reappear on the outer side and be swallowed up in eddies by the corresponding pulmonary vein, which conducts them to the pericardium opposite the anterior orifices.

The whole of the blood which reaches the heart has not previously passed through the lungs. As a matter of fact globules may be observed at the sides of the abdomen, which, issuing probably from the mass of the liver, appear beneath the integument and there circulate until they reach the pericardium, whence they penetrate into the heart. In young specimens of *Pardosa* I have seen globules leave the two abdominal currents, some near the spinnerets and the others towards the middle of the ventral face, pass round the sides of the abdomen and fall directly into the pericardium. Finally, in some young individuals of *Pardosa* and *Heliophanus* globules, instead of penetrating into the lung, skirted its external border, and then, circulating beneath the integument, passed directly into the pericardium.

In conclusion: the vascular system, which is very little ramified in newly hatched spiders, becomes complicated later on; the venous blood circulates in a very extensive series of lacunæ. The whole of the venous blood of the cephalothorax is arterialized before reaching the heart; a portion of that of the abdomen returns directly to the pericardium, and from thence to the heart, without passing through the lungs.—*Comptes Rendus*, t. cxiv. no. 18 (May 2, 1892), pp. 1035–1038.

A Contribution to the Knowledge of the Anatomical Structure of the Sexual Organs in the Galeodidæ. By A. Birula, of the Zootomical Institute of the University of St. Petersburg. (Provisional Communication.)

The chief results of my investigations into the anatomico-histological structure of the genital organs in the Galeodidæ are the following.

My studies were conducted upon:—

a. *Galeodes araneoides*, Pall. (♂ & ♀);
b. *Galeodes ater*, Bir. (♀).

The male genital organs are constructed as follows:—

1. The external genital aperture is represented by a longitudinal slit in the protuberance of the posterior margin of the first abdominal segment;

2. Aciniform (so-called accessory) glands, with a chitinized intima, open into the uterus masculinus, which is clothed with chitin;

3. Each of the seminal ducts (vasa deferentia) divides in the third abdominal segment into two rami, which, suddenly narrowing, pass into the filiform testes;

4. In the walls of each vas deferens, at their opening into the uterus masculinus, lie aciniform accessory glands, with columnar epithelium, but without an intima;

5. At the period of the maturity of the sexual products the end of each ramus of the vasa deferentia, which is histologically indistinguishable, swells up into a vesicle and functions as a vesicula seminalis;

6. The testes consist of four thin and very long coiled tubes, which,

before they open into the vesicula seminalis, lose their typical epithelium and form

7. The special glandular portion, which serves to secrete the chitinous substance for the membrane of the spermatophores ;

8. The semen enters the sexual organs of the female in the form of oval and somewhat flattened spermatophores.

The female sexual organs are constructed in the following manner:—

1. The external genital aperture has the same appearance as in the male ;
2. The vagina is clothed with a thick chitinized intima ;
3. The receptacula seminis are represented by two vesicles with chitinized intima, and open into the vagina in the neighbourhood of the genital aperture ;
4. On its posterior wall the uterus is provided with two auriculate appendages, which do not differ in histological structure from the remaining portions of the uterus, and, as it appears, play no physiological part whatever ;
5. The oviducts pass immediately into the ovaries. The walls of these two sections are longitudinally folded, in consequence of which when the sexual organs become filled with ova or spermatophores they are capable of considerable expansion, whereby the cavity of the organs is increased ; they consist of (*a*) the external adipose layer, (*b*) the circular musculature, (*c*) the longitudinal musculature, (*d*) the tunica propria, and (*e*) the columnar epithelium. In the first three layers an abundant ramification of tracheæ is observable ;
6. The ova develop from a special epithelial layer, which clothes the wall of the ovaries on the interior ;
7. The ripe ova, which already lie in the follicles which become evaginated, have a so-called " stylum " * ;
8. In the cavity of the ovaries and of the oviducts there may be observed a considerable number of free cells which bear a strong resemblance to the blood-corpuscles. The cells possess the power of amœboid movement and exhibit figures of karyokinetic division. They demolish the envelopes of the spermatophores, thereby liberating the spermatozoa, and at the same time destroy the superfluous spermatozoa and the unfertilized ova † ;
9. The ripe ova fall into the cavity of the ovaries, where the development of the embryo is completed ;
10. Even before the formation of the rudiments of the appendages a great difference in form is noticeable between the thoracic

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* Bertkau, " Ueber den Generationsapparat der Araneiden," Archiv f. Naturgeschichte, 1875, p. 245.

† Corpuscles of this kind have been described by Prof. A. Schneider in *Nephelis*, *Aulostomum*, and *Hirudo*—A. Schneider, " Ueber die Auflösung der Eier und Spermatozoen in den Geschlechtsorganen," Zool. Anz. 1880, no. 46, p. 19.

and abdominal segments of the germinal streak. The segment which bears the cheliceræ is separated later than the remainder of the thoracic segments, at a period when from three to four abdominal segments have arisen from the caudal section;

11. The segmentation of the appendages appears at a somewhat early stage;

12. There are no embryonic envelopes;

13. A flexure of the embryo takes place, as in the Araneina;

14. The lateral organs, which were described by Croneberg *, are represented in younger stages by large elongate vesicular sacs, which are connected with the body above the first pair of legs by means of a thin stalk. In the young immediately after birth the lateral organs are considerably diminished in size and shrunken. In the adult animal, apparently, the linguiform triangular folds of skin which are found beneath the mandibles must be regarded as a remnant of the lateral organs.—*Biologisches Centralblatt*, xii. Bd., no. 22 (November 15, 1892), pp. 687–689.

On Two Species of Myzostoma *parasitic upon* Antedon phalangium, *Müller.* By M. Henri Prouho.

Antedon phalangium is the host of two species of *Myzostoma* described by von Graff under the names *Myzostoma pulvinar* and *M. alatum*, and which were both discovered in the Minch during the expedition of the 'Porcupine.' I have met with these two parasites on their usual host in the dredgings made in the course of last summer by the boat belonging to the Arago Laboratory; and this enables me to communicate forthwith certain interesting features in the history of these Myzostomidæ, which are so little known. I pass over the anatomical and histological details, which will be dealt with elsewhere.

Myzostoma pulvinar.—Herr von Graff, whose description of this species was founded upon a unique specimen, has well characterized its external form; he has drawn attention to the dorsal position of the mouth and the cloacal orifice, but he must have been led astray by the bad state of preservation of the specimen which he studied, for he states that the organs which are known in the other species of *Myzostoma* under the name of *suckers* are absent in this form, though these structures are really present, although not so well developed as in the majority of the other species.

Contrary to the opinion of von Graff, *Myzostoma pulvinar* does not live upon the disk of *Antedon phalangium*; it inhabits the

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* A. Croneberg, "Ueber ein Entwicklungsstadium von *Galeodes*," Zool. Anz., 10 Jahrg., 1887.

alimentary canal of its host, in which it is sufficiently deeply ensconced to be invisible from the exterior. The *Myzostoma* occupies almost the whole of the first portion (œsophagus and stomachal sac) of the alimentary canal of the *Comatula*, and is situated in such a way that its anterior extremity is turned towards the aboral pole. It applies itself by its ventral face, which is very convex and bears the ten parapodia, to the digestive epithelium of the *Comatula*, while its concave dorsal surface, looking towards the buccal orifice of the latter, forms a channel which affords a passage to the food-currents, which nourish at once host and parasite. The gutter-like form of the dorsal surface of *Myzostoma pulvinar* explains how it is that the latter, in spite of its considerable dimensions, does not completely obstruct the alimentary canal of the *Comatula*.

Myzostoma pulvinar, which is the first endoparasitic form belonging to this genus with which we are acquainted, is a diœcious species with well accentuated sexual dimorphism. In this, as in other points of its organization, it approaches the cysticolous members of the genus.

In linear dimensions the female is four and a half times larger than the male; it measures 4·5 millim. in each direction. It presents no trace of testes either in the adult or young state. As in the hermaphrodite species, its uterus communicates with the exterior by three ducts—a median one, which is a direct prolongation of the uterus itself, and two lateral ones, which open into the anterior portion of the cloaca (rectum).

The male only measures 1 millim. in length by 0·8 millim. in breadth; it hooks itself on to the integument of the female, upon which it is able to move pretty rapidly. In shape it is flattened and elliptical, recalling by the form of its body the free species of *Myzostoma*. Its alimentary canal is not branched, but exhibits on each side indications of the three ramifications which are seen in all the other species of the genus; its mouth, which is situated quite close to the marginal border, is ventral in position. It possesses two testes, one on each side of the alimentary canal, and each provided with a vas deferens which opens on the ventral surface.

The two sexes must become associated at a very early period, for I have observed a young female measuring 1·7 millim. in length which bore upon its back a male of 0·7 millim. The female in this instance did not as yet present any trace of ovaries, but already had the characteristic form of the adult.

Myzostoma alatum.—This species lives as a parasite upon the disk of *Antedon phalangium*, and its relations to its host are the same as those of *Myzostoma glabrum* to *Antedon rosacea*: its anatomy does not essentially differ from that of *Myzostoma glabrum*. Like the latter it is hermaphrodite, and my object in drawing attention to this species is occasioned by the fact that the observations which I have been able to make with regard to it raise a serious doubt as to the existence of the so-called *complemental* males in the hermaphrodite species. It is true that there are very frequently found upon the dorsal surface of *Myzostoma alatum* what are supposed to be complemental males to the number of one or two, which exactly recall those which were described by Beard in *Myzostoma glabrum,* and which von Graff had probably been right in considering as young ones. Now a series of observations has convinced me, without any possible doubt, that the individuals attached to the dorsum of the hermaphrodite *Myzostoma alatum* are young ones of the same species, which, while they are males in their youth, with well-developed spermatozoa and vasa deferentia equal to those of the adult, *increase in size and acquire during growth ovaries which are identical with those of the hermaphrodite form which bears them*, and this without abandoning the dorsal surface of the latter. These supposed complemental males moreover possess, even in their youth and at a time when they show no trace of ovaries, genital ducts corresponding to the female genital ducts of the hermaphrodites (a fact which has already been observed by Nansen in *Myzostoma giganteum* and *M. Carpenteri*).

The complemental male therefore has no existence, in the proper sense of the word, in the case of *Myzostoma alatum.* This species is a proterandrous hermaphrodite form, in which the two male and female genital glands coexist in the adult. That the young male at the outset of its existence plays the part of a complemental is possible, but it is not proved; and in all cases its male condition is only transitory, which indicates perhaps that hermaphroditism in *Myzostoma* is an acquired condition, and not a primitive one.

I do not as yet possess proof that the complemental males of *Myzostoma glabrum* also acquire ovaries; but the facts which I have observed in the case of *Myzostoma alatum* lead me to believe that they do.

In conclusion, I would remark that the four species of *Myzostoma* with which we are at present acquainted as existing in the Mediterranean present us with three, or perhaps even with four, types, which are of interest from the point of view of the sexual organization of the genus *Myzostoma*, viz.:—

Hermaphrodite type, *Myzostoma cirriferum.*
Proterandrous hermaphrodite type, *Myzostoma alatum.*
Hermaphrodite type with complemental male (?), *Myzostoma glabrum.*
Diœcious type with dwarf male, *Myzostoma pulvinar.*

—*Comptes Rendus*, t. cxv. no. 20 (November 14, 1892), pp. 846–849.

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[SIXTH SERIES.]

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XV.—*Natural History Notes from H.M. Indian Marine Survey Steamer 'Investigator,' Commander C. F. Oldham, R.N., commanding.*—Series II., No. 7. *An Account of the Collection of Deep-sea Asteroidea.* By A. Alcock, M.B., Surgeon-Captain I.M.S., late Naturalist to the Survey.

[Plates IV.-VI.]

§ 1. *Introduction.*

The Starfishes to be described in the sequel have been dredged since the year 1885, all in water over 100 fathoms, most in water over 200 fathoms, and very nearly half in water over 1000 fathoms deep. A large collection of littoral and shallow-water forms has also been made, but these are not here considered. If it be thought objectionable to have separated the deep-water from the shallow-water forms, it may be urged in justification that within the limits of Indian seas, so far as our experience at present goes, there is no instance of the two sections overlapping, and, on another ground, that almost nothing has been published, and nothing else is promised, about the extremely interesting Asteroidea of the deeper waters of India. Of the basins into which these waters may conveniently be divided the Bay of Bengal proper—the basin best explored by the dredge so far—gives us the smallest number of unknown species. Beyond the limits of the 30-fathom line it would seem as if the overwhelmingly muddy bottom of the Bay presented conditions specially unfavourable to the existence of starfishes; and after passing this limit we usually dredge nothing until we reach true bathybial conditions in the middle of the Bay. At 561 fathoms on the Andaman side, however, we have met with *Brisinga*, and at about 500–700 fathoms, opposite to the Godávari and Kistna Deltas, on a bottom of hardening clay that seems to be a special habitat for *Flabellum* (*japonicum* and *laciniatum*), *Bathyactis*, *Phormosoma*, and Spatangoids, *Pentagonaster* again appears. When we come to the middle of the Bay, where *Globigerina*-ooze is accumulating, we find forms that are familiar to deep-sea explorers all the world over, namely *Pararchaster*, *Dytaster*, *Porcellanaster*, *Styracaster*, *Hyphalaster*, *Paragonaster*, *Zoroaster*, *Marsipaster*, *Hymenaster*, and *Freyella*.

The enclosed basin of the Andaman Sea in its moderate depths appears to be peculiarly favourable to starfish life, though of its greatest depths—600 to 1200 fathoms—we know nothing. The calcareous sand and ooze (coral, *Globigerina*, and Pteropod) accumulating between 200 and 300 fathoms seems to afford to Asteroids, as to Ophiuroids and Echinoids, an optimum of development. Not only is there abundance, but there is also variety. Though our dredgings have been few, they have brought in twenty-one species, of which sixteen (including three remarkable generic types) are new to science. The species belong to the following genera:—*Pseudarchaster*, *Porcellanaster*, *Astropecten*, *Pentagonaster*, *Dorigona*, *Nymphaster* (common), *Anthenoides*, *Palmipes*, *Chætaster*, *Zoroaster* (common), *Cribrella*, *Pedicellaster*, *Stolasterias*, *Brisinga*, *Persephonaster* (near *Plutonaster*), *Dipsacaster* (an Astropectinoid), *Milteliphaster* (near *Calliaster*), and *Dictyaster* (near *Plectaster*).

Concerning the Laccadive Sea our limited zoological knowledge is almost entirely confined to the depths (700 to 1200 fathoms) in the immediate vicinity of the atolls. The Gulf of Manaar may here be very naturally included. The calcareous bottoms of these basins seem to be very favourable to starfishes, and we have in a few hauls found representatives of eighteen species of the following genera:—*Pararchaster*, *Pontaster* (very common), *Porcellanaster*, *Pentagonaster*, *Nymphaster*, *Mediaster*, *Zoroaster* (common), *Brisinga*, and *Persephonaster*.

Our observations have done but little to illustrate the habits of life of the deep-sea Asteroidea. Like some of the common reef-forms they must sometimes live in swarms, as, for instance, *Zoroaster carinatus*, of which over a score have been taken at one haul, *Pontaster hispidus*, of which about fifty have been dredged at the same time, and *Nymphaster florifer*, of which a hundred and fifty have come up on the tangle-bar. Like their shallow-water relatives they seem to subsist largely on mollusks, the shells of which, along with the chitinous remains of prawns and amphipods, are often to be found in their stomachs; but some of the characteristic bathybial forms, as *Pararchaster*, *Pontaster*, *Porcellanaster*, *Styracaster*, and *Hyphalaster*, appear to gorge themselves with *Globigerina*-ooze. A curious case of symbiosis, which has been observed too often to be a merely accidental association, occurs between *Dictyaster xenophilus* and an annelid.

Some of the species noticed in this paper have already been described in joint papers by Professor Wood-Mason and myself upon the recent dredging-operations of the 'Investigator;' but owing to the discovery of further material in the examination of the collections of former years, I have found it necessary to amend the diagnoses of *Persephonaster* and *Dictyaster*, and I have redescribed *Dytaster anacanthus*, *Persephonaster croceus*, *Persephonaster rhodopeplus*, *Dictyaster xenophilus*, and *Asterias mazophorus*, and have more fully described three species of *Brisinga*, namely *B. insularum*, *B. andamanica*, and *B. bengalensis*, which before were merely named.

I have to express my great obligations to Mr. Sladen's classical volumes on the 'Challenger' Asteroidea, to which I owe guidance on every point. Mr. Sladen's classification is followed throughout, in the conviction that it is the expression of natural relations.

§ 2. *List of the Asteroidea, with Descriptions of the Species believed to be new.*

Family **Archasteridæ.**

PARARCHASTER, Sladen.

1. *Pararchaster semisquamatus*, Sladen.

Pararchaster semisquamatus, Sladen, 'Challenger' Asteroidea, p. 7, pl. ii. figs. 1 and 2, pl. iv. figs. 7 and 8; and in Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, p. 428.

Bay of Bengal, on a bottom of *Globigerina*-ooze, in 1664 fathoms.

Colour uniform salmon-red.

2. *Pararchaster Huddlestonii*, sp. n.

Rays 5. R=11 *r*. R=about 170 millim. in the type specimen.

Disk very small; rays depressed, very long, tapering.

Abactinal surface covered with small, rather distant, unequal-sized nodular plates, each of which bears a single erect acute spine or spinelet, the spines on the disk being very stout and measuring in the type specimen 5 to 8 millim. in length, while the spinelets on the rays are small and slender and decrease in length from about 2 millim. near the base to less than a millim. at the periphery of the ray.

Supero-marginal plates more than 60, entirely lateral and slightly oblique in position, elongate, oval, tumid; each with a central tubercle bearing a stout acute spine with a basal circlet of spinelets, one of which is sometimes considerably enlarged, especially in the interbrachial region; the odd interbrachial plate is in the form of a salient eminence, upon which stands a spike of preeminent size with a basal circlet of spinelets larger than those on the other plates.

Infero-marginal plates alternate with the supero-marginals and very oblique, elongate, pyriform, tumid; each bears usually three stout sharp spines in an oblique series, the most abactinal being the largest and often having at its base a pair of spinelets; in the interbrachial arc the spines, especially those of the odd plate, are a good deal aborted. The intervals between the infero-marginal plates throughout the ray are occupied each by a large multivalve or pectinate pedicellaria.

Adambulacral plates large, broad, tumid, each with a furrow-series of six to eight compressed obtuse spinelets in a semicircular comb, and with three spinelets obliquely placed on its actinal surface, the two of these nearest the furrow being of conspicuous size.

Mouth-plates large, each with a furrow-series of six or seven spinelets, increasing in size from periphery to centre, and with a suture-series of three much larger spinelets.

Actinal interradial areas very small, not extending beyond the second or third marginal plate; the intervals between the plates occupied by large multivalve (pectinate) pedicellariæ, but the plates are otherwise quite unarmed usually.

Anus subcentral. Madreporiform plate large, subcircular, flat, with fine radial striations.

Ambulacral furrow wide; tube-feet very large, with a small sucker at point.

Papulæ confined to rudely stelliform areas at the very base of the rays, reaching to the level of the fourth marginal plate.

Bay of Bengal, Carpenter's Ridge, 1520 fathoms, *Globigerina*-ooze.

3. *Pararchaster violaceus*, sp. n.

Rays 5. R = 9–10 *r*. R = about 100 millim. in the type specimen.

Disk very small; rays depressed, very long, tapering.

Abactinal surface covered with close-set nodular plates of unequal size, each of which bears from two to four minute capillary spinelets, visible only with a lens on the rays, but plain to the naked eye on the disk, where a few in the centre become distinct spines.

Supero-marginal plates more than 35, entirely lateral and slightly oblique, elongate, rudely oval, tumid; each with a central tubercle, bearing a very stout and sharp spine surrounded at its base by three to five spinelets, one or two ot which are usually large; the odd interbrachial plate is a salient eminence which supports a spike of preeminent size rising out of a circle of large spinelets.

Infero-marginal plates alternate with the supero-marginals and oblique, elongate, pyriform, tumid; each with two stout sharp spines, of which the upper is nearly equal in size to and the lower about half the size of the supero-marginal spine, and with several distant spinelets; in the interbrachial arcs the spaces between the plates to the number of four are occupied each by a large pectinate pedicellaria.

Adambulacral plates large, broad, tumid; each with a furrow-series of seven or eight obtuse spinelets in a semicircular comb, and actinally with two large spinelets. Mouth-plates large, each with a furrow-series of seven or eight spinelets, increasing in size from periphery to centre, and with a suture-series of two much larger spinelets.

Actinal interradial areas extremely small, with apparently in each area only two pairs of distantly spinate plates and a large pectinate pedicellaria between each pair.

Anus subcentral and very distinct. Madreporiform plate rather large, strongly convex, with close radial striations.

Ambulacral furrow narrow.

Papulæ confined to oval areas quite at the base of the rays, reaching only to the level of the second marginal plate.

Colours in the fresh state delicate pink, with the disk violet owing to the mud contained in the stomach and its cæca.

Laccadive Sea, 1200 fathoms, coral and *Globigerina*-ooze.

PONTASTER, Sladen.

4. *Pontaster mimicus*, Sladen.

Pontaster mimicus, Sladen, 'Challenger' Asteroidea, p. 48, pl. vi. figs. 1 and 2, pl. vii. figs. 5 and 6.

Laccadive Sea, 1000 fathoms, olive mud.

5. *Pontaster cribellum*, sp. n.

Rays 5. R = 5 *r*. R = 45 millim. in the type specimen.

Very closely related to *P. subtuberculatus*, Sladen, from the South Pacific Ocean.

No pedicellariæ of any kind present.

Disk of moderate size; rays rather short.

Abactinal surface covered with small paxillæ formed of from six to twelve uniformly minute spiniform granules, three or four round the madreporiform body, and one in each interradius having about twenty granules.

Marginal plates uniformly covered with similar granules.

Supero-marginal plates about 21, broad, tumid, almost entirely abactinal in position, articulating rather obliquely with one another; each with a central eminence supporting a single stout sharp spine.

Infero-marginal plates broad, tumid, alternating with the supero-marginals in the basal half of the ray, coinciding with them in the distal half; each with a stout sharp spine at its upper (abactinal) end.

Adambulacral plates distant, broad, each with a furrow-series of about twelve spinelets, standing in an almost circular palisade round a single large actinal spine. Mouth-plates large, each with a furrow-series of six or seven spinelets, of which the most central (adoral) is many times larger than any of the others and slightly larger even than the large actinal spine of the plate, and with a suture-series of small spinelets.

Actinal interradial areas small, not extending beyond the third adambulacral plate, and carrying only about six finely spinate plates.

Anus central, distinct. Madreporiform plate small, situated midway between the centre and the margin of the disk, and outside a very big paxilla.

Papularia small and compact, with only five or six papulæ in each.

Colour in the fresh state delicate pink.

Laccadive Sea, 1200 fathoms, coral and *Globigerina*-ooze.

6. *Pontaster hispidus*, Alcock and Wood-Mason.

Pontaster hispidus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 428.

This species is very closely related both to *P. forcipatus*, Sladen, and to *P. mimicus*, Sladen, but especially to *P. forcipatus*, var. *echinata*, Sladen, from the southern limit of the Indian Ocean.

Abundant on the green mud of the Laccadive Sea at about 1000 fathoms.

7. *Pontaster pilosus*, sp. n.

Also allied to *P. mimicus*.

Rays 5. R=about 6 *r*. R=70 millim. in the type specimen.

Disk of moderate size; rays rather long.

Abactinal surface covered with densely crowded spinose paxillæ of two kinds in nearly equal proportions, the one kind crowned with about eight spinelets of uniform size, the other kind bearing also a central spine—these, seen in mass, producing a shaggy appearance.

Marginal plates extremely tumid, uniformly invested with capillary spinelets.

Supero-marginal plates 30 to 35, forming a broad abactinal border to the disk and rays, each with a large spine quite on its inferior (actinad) margin. [In *P. hispidus* the spine is quite on the superior (abactinad) margin of the plate.]

Infero-marginal plates alternate with the supero-marginals nearly to the tip of the ray, each with a large spine at its superior (abactinad) margin, and with from one to three much smaller and slenderer spines vertically beneath it.

The distant adambulacral plates are so convex marginally as almost to meet from opposite sides across the furrow; each has a furrow-series of about eight spinelets upstanding in a semicircle around a large actinal spine, which is nearly as big as the spines of the corresponding supero-marginal plate; outside the actinal spine an irregular row of capillary spinelets completes the circle with the furrow spinelets. The mouth-plates are hardly modified from this type, but, like the first two or three adambulacral plates, they bear two large actinal spines, and the most central (adoral) furrow-spine is conspicuously enlarged.

The actinal interradial areas form small crescents, the horns of which touch the proximal end of the third infero-marginal plates; each area carries 21 to 24 small plates in three concentric rows, the plates being closely covered with capillary spinelets, which occasionally fall into the semblance of a pectiniform pedicellaria, and sometimes bearing also a central spine.

Anus subcentral. Madreporiform plate small, placed about midway between the centre and the margin of the disk.

Papularia small and compact, each with about 10 papulæ.

No true pedicellariæ.

Gulf of Manaar, 597 fathoms, green mud.

DYTASTER, Sladen.

8. *Dytaster exilis*, Sladen.

Dytaster exilis, Sladen, 'Challenger' Asteroidea, p. 65, pl. ii. figs. 3 and 4, pl. iv. figs. 9 and 10; and in Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, p. 429.

This species has several times been met with in the Bay of Bengal between 1748 and 1924 fathoms on *Globigerina*-ooze.

9. *Dytaster anacanthus*, Alcock and Wood-Mason.

Dytaster anacanthus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 429.

Rays 5. R=about 6 *r*. R=82 millim. in the
type specimen.

Disk small, irregularly inflated; rays long, narrow, rigid, tapering; interbrachial arcs rather acute.

Abactinal surface densely crowded with small paxillæ formed of narrow tabulæ capped with numerous close-set granules or papilliform spinelets, those in the centre of the disk and in a narrow band along the middle of the rays being smaller than those elsewhere, and those on the rays being disposed in obliquely transverse rows on each side of this median band.

The supero-marginal plates, 40 to 45 in number, are entirely vertical and lateral in position, almost perfectly square, except in the interbrachial arcs, where their vertical diameter is greater, and are uniformly covered with papilliform granules without any enlarged spines or tubercles.

The infero-marginal plates correspond in number, size, and shape with their exactly superposed fellows of the upper marginal series; they are uniformly covered with papilliform granules, and, except in the apical third of the ray, each bears near the middle of its distal (aboral) margin a long fine accumbent spine, and often another, and occasionally two other, similar but smaller spines vertically below the first.

Adambulacral plates long and large, fairly coinciding base to base with the infero-marginals, each with a straight furrow-comb of 6 to 8 equal obtuse spinelets, and actinally with a dense mass of smaller spinelets which usually fall into three fairly distinct longitudinal series. Mouth-plates very prominent, with widely open sutures, and with the most central (adoral) furrow spine enormously enlarged; actinally each plate is thickly covered with spinelets in a triserial arrangement.

Actinal interradial areas narrow, but extending to the eleventh or twelfth infero-marginal plate, and bearing thickly spinulate plates, the spinelets of which have a tendency to fall into pedicellaria-like clumps.

Anus distinct, central, forming a longish chink-like vent to a short broad intestine. Madreporiform plate placed near the margin of the disk and much concealed by paxillæ.

Colour in the fresh state uniform light rose-madder.

Bay of Bengal, 1748 fathoms, *Globigerina*-ooze and pumice.

The determination of the relations of this species has always given me great trouble. Of described and figured bathybial starfishes it comes nearest to *Psilaster gracilis*, Sladen ('Challenger' Asteroidea, p. 230, pl. xli. figs. 5 and 6, pl. xlii. figs. 9–11), which Mr. Sladen states to be so far different from all its congeners that he only places it with them with hesitation. As far as mere external characters go, our species seems to agree with *Psilaster gracilis* in almost every detail; but I have satisfied myself by dissection that our species has an alimentary canal with both ends opening to the exterior, and for the present I leave it with *Dytaster*.

PERSEPHONASTER, Alcock and Wood-Mason.

Close akin to *Plutonaster*, Sladen.

Disk large, flat; rays of moderate length, rigid.

Marginal plates more or less covered with papilliform spinelets and bearing each one or many strong rigid spines: the supero-marginals, which form a broad massive border on the abactinal surface of the disk and rays, directly superposed to the infero-marginals, plate to plate.

Abactinal surface covered with close-set paxillæ, which on the rays are arranged in curved transverse rows without any enlarged median series; papulæ distributed everywhere between the paxillæ.

Actinal intermediate areas large, extending far along the ray; the plates closely covered with coarse spinelets.

Adambulacral plates with a furrow-series of obtuse, compressed, slightly radiating spinelets, and actinally with two longitudinal series of coarse papilliform spinelets.

All the spinelets on the actinal surface of the animal are covered with membrane and are grooved, somewhat resembling pedicellariæ to the casual view.

Anus distinct, subcentral. Madreporiform body small, concealed, distant from the margin of the disk.

No true pedicellariæ are present.

The generative glands have the usual position in the interbrachial arcs.

The ambulacral furrow is remarkably wide.

This genus was first defined in the Ann. & Mag. Nat. Hist., Dec. 1891, p. 430. The examination of further material now permits more precision in the definition.

10. *Persephonaster croceus*, Alcock and Wood-Mason.
(Pl. IV. figs. 1, 2.)

Persephonaster croceus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 430.

Rays 5. R$=4{\cdot}5\,r$. R$=95$ millim. in the type specimen.

Disk and rays quite rigid, their abactinal surface covered with close-set spinose paxillæ, which become small and very crowded towards the subcentral anal aperture, and are arranged in transverse series on the rays; a few incipient pedicellariæ adjoin the marginal plates on the disk; the whole abactinal surface is perforated by close-set papulæ.

The very massive supero-marginal plates number 31, and are directly superposed on the infero-marginals, plate to plate; each is coarsely granular in the centre and finely spinulate at the edges, and each bears two sharp rigid spines, one at the abactinal, the other near the actinal end, the former being the smaller and often bifid.

The massive infero-marginal plates correspond, plate to plate, with the supero-marginals; they are uniformly covered with papilliform granules, which are largest in the middle of the plate, and each bears near its upper (abactinad) end a sharp rigid spine, beneath which is an obliquely vertical row of three or four very slender accumbent spines.

Adambulacral plates with the furrow-margin slightly convex, and armed with a comb of six or seven longish compressed spinelets; actinally each carries two longitudinal series of small inflated membrane-clad spinelets, which are grooved down the middle like a barley-corn, four in each series. Mouth-plates small, tumid, with a close suture; each with a furrow-series of about seven spinelets, the most central (adoral) of which is of enormous relative size, and with two longitudinal series of close barleycorn spinelets.

Actinal interradial areas large, the intermediate plates extending to the thirteenth or fourteenth infero-marginal; all are closely covered with barleycorn spinelets, which in the plates adjoining the adambulacrals fall into clumps resembling multivalve pedicellariæ.

Madreporiform plate small and inconspicuous, placed about two diameters from the margin of the disk.

Ambulacral groove extremely broad; tube-feet large, conical. The spirally coiled sacculated intestine opens at a distinct subcentral vent.

Colour in the fresh state olive-yellow, marginal plates pink, tube-feet red.

Gulf of Manaar, 738 fathoms, green mud.

This species, like the rest, seems to resemble *Psilaster patagiatus*, Sladen ('Challenger' Asteroidea, p. 232, pl. xli. figs. 3 and 4, pl. vii. figs. 11 and 12), which Mr. Sladen considers to be an abnormal Astropectinoid of Archasteroid affinities, and quite unlike any other species of *Psilaster*.

11. *Persephonaster rhodopeplus*, Alcock and Wood-Mason.

Persephonaster rhodopeplus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 431.

Rays 5. R = 3·5 *r*. R = about 65 millim. in the type specimen.

Disk and rays quite rigid, their abactinal surface covered with very close-set tabulate paxillæ surmounted by numerous uniform flat-topped granules; the paxillæ are very small and crowded towards the subcentral anal aperture, and on the rays fall into transverse curved rows; the whole abactinal surface is perforated by close-set papulæ.

The supero-marginal plates number about 28, and are directly superposed on the infero-marginals, plate to plate; they are covered with granules, which are coarse and distant in the middle of the plate, and are armed with sharp rigid spines—those in the interbrachia with one, those along the rays with one, or with two or three in a vertical series; at the base of the rays each plate usually bears on its extreme abactinal edge one or two incipient pedicellariæ.

The infero-marginal plates correspond, plate to plate, with the supero-marginals; they are almost smooth in the middle and are covered with papilliform granules round the edge, and are armed with from two to four stout accumbent spines in a median vertical series, the most abactinad being the largest.

Adambulacral plates with a strongly convex furrow-margin armed with six to eight short, truncated, longitudinally-grooved spinelets, and actinally with two longitudinal series of similar spinelets, about five in each series; these spinelets are sometimes almost clavate. Mouth-plates small, very narrow, with the suture widely open; each with a furrow-series of about ten spinelets, of which the most central (adoral) is much enlarged, and with a single suture-series of eight or nine barleycorn spinelets.

Actinal interradial areas large, the intermediate plates extending to about the eighteenth infero-marginal; in the interradial areas each plate carries a pedicellaria-like clump of from six to eight truncate or clavate grooved spinelets, and along the rays each usually carries two short longitudinal series of similar spinelets.

Madreporiform plate small and inconspicuous or quite concealed; placed about midway between margin and centre.

Ambulacral groove very broad; tube-feet large, conical.

The intestine is similar to that of *P. croceus* and opens by a long narrow vent.

Colour in the fresh state "crushed strawberry," with sometimes a golden suffusion; marginal plates pink, tube-feet blood-red.

Laccadive Sea and Gulf of Manaar, 738 to 902 fathoms, green mud.

In a very young specimen a granular epiproctal tube is observed.

12. *Persephonaster cœlochiles*, sp. n.

Rays 5. R=4·75 *r*. R=117 millim. in the type specimen.

Disk thin, flat, flexible; rays very broad at base, but tapering to a fine point, thin and flat, with a remarkably broad ambulacral furrow.

Abactinal surface with close-set paxillæ consisting of a slender cylindrical column crowned by a thick brush of capillary spinelets; the paxillæ of the disk small and irregularly placed, those on the rays in beautifully regular transverse rows; the whole abactinal surface closely perforated with papulæ.

Supero-marginal plates 42, superposed on the inferomarginals, plate to plate; almost entirely abactinal in position; closely covered with membrane-clad granules, and bearing at the actinad end each a stout procurrent spine.

Infero-marginal plates corresponding, plate to plate, with the supero-marginals, covered with similar granules, and armed with an obliquely vertical series of, usually, three stout procurrent spines.

The adambulacral plates are practically within the furrow, lying far below (*i. e.* above in the normal position of the animal in life) the level of the infero-marginals; they are distant *inter se*, and their slightly convex furrow-margin bears a comb of, usually, six long needle-like spinelets, while on the actinal surface there are two longitudinal rows of inflated membrane-clad barleycorn spinelets. Mouth-plates long and large, extremely tumid actinally; each with a furrow-series of seven or eight spinelets, the most central (adoral) of which is of enormous relative size, with a suture-series of ten or eleven spinelets, of which the most central is enlarged, and with a few scattered granules between.

Actinal interradial areas narrow, but long, the intermediate plates reaching in a discontinuous series to the twenty-third infero-marginal, and those along the ray lying in a furrow between the adambulacrals on the one side and the inferomarginals on the other; each plate with a clump of barleycorn spinelets.

Madreporiform plate small, somewhat concealed by paxillæ; placed midway between margin and centre.

Anus central, distinct, receiving the termination of a wide intestine.

Ambulacral groove of great width, its width being two fifths that of the ray; tube-feet very large, conical, in two rows.

Andaman Sea, 230 to 250 fathoms.

This species is readily distinguished by the actinal hollowing of the rays and by the flexibility of the disk.

PSEUDARCHASTER, Sladen.

13. *Pseudarchaster mosaicus*, Alcock and Wood-Mason.

Pseudarchaster mosaicus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 432.

Andaman Sea, 188 to 220 fathoms, green mud.

Family **Porcellanasteridæ.**

PORCELLANASTER, Wyville Thomson.

14. *Porcellanaster cœruleus*, Wyville Thomson.

Porcellanaster cœruleus, Wyville Thomson, Voy. Chall. Atlantic, vol. i. p. 378, figs. 97 and 98; Sladen, 'Challenger' Asteroidea, p. 134, pl. xx.; and in Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, pp. 433 and 434.

Andaman Sea, 683 fathoms, blue mud; Laccadive Sea, 738 fathoms, green mud; and Bay of Bengal, 1664 to 1748 fathoms, *Globigerina*-ooze.

STYRACASTER, Sladen.

15. *Styracaster horridus*, Sladen.

Styracaster horridus, Sladen, 'Challenger' Asteroidea, p. 150, pl. xxiii. figs. 5–7, pl. xxvii. figs. 17–20; and in Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, p. 434.

Bay of Bengal, 1748 and 1803 fathoms, *Globigerina*-ooze and pumice.

16. *Styracaster armatus*, Sladen.

Styracaster armatus, Sladen, 'Challenger' Asteroidea, p. 153, pl. xxiv. figs. 1–4, pl. xxviii. figs. 1–4.

Bay of Bengal, 1840 and 1924 fathoms, *Globigerina*-ooze.

17. *Styracaster clavipes*, Alcock and Wood-Mason.

Styracaster clavipes, Ann. & Mag. Nat. Hist., Dec. 1891, p. 434.

Bay of Bengal, 1748 fathoms, *Globigerina*-ooze and pumice.

HYPHALASTER, Sladen.

18. *Hyphalaster tara*, Alcock and Wood-Mason.

Hyphalaster tara, Ann. & Mag. Nat. Hist., Dec. 1891, p. 434.

Bay of Bengal, 1748 and 1997 fathoms, *Globigerina*-ooze and pumice.

Family **Astropectinidæ.**

ASTROPECTEN, Linck.

19. *Astropecten*, sp.

A small *Astropecten*, which I think is undescribed, occurs in the Andaman Sea at about 250 fathoms.

DIPSACASTER, gen. nov.

Disk large, with flat rigid rays of moderate length. Abactinal surface of disk and rays with compact definitely arranged paxillæ and numerous intervening papulæ.

Marginal plates with highly developed ridges and fasciolar channels; the infero-marginals with enlarged spines.

Actinal interradial areas large, with numerous intermediate plates extending far along the ray, and bearing compact rosettes of spinelets.

Adambulacral plates with a palmate or pectinate furrow-series of spinelets, and actinally with several series of spinelets arranged in rosette-like groups.

Madreporiform plate large but concealed.

No anus exists, and though a minute pore is present in the centre of the disk, it has no communication with the lumen of the intestine. No pedicellariæ.

20. *Dipsacaster Sladeni*, sp. n. (Pl. V. figs. 3, 4.)

Rays 5. R = 3 to 3·3 *r*. R = 110 millim. in the type specimen.

Disk large, quite flat; rays very broad, quite flat, bluntly pointed; interbrachial arcs wide.

Abactinal surface densely covered with paxillæ which have broad bases, long slender cylindrical pedicles, and a glomerular crown of crowded capillary spinelets; the paxillæ are arranged with beautiful regularity in close series of chevrons, the angles of the chevrons pointing to and converging at the centre of the disk.

The marginal plates have the form of great salient cubical blocks, separated from one another by deep trenches; they are densely covered with papillary granules, which at the edges become capillary spinelets that stretch across and completely fill up the trenches.

The supero-marginal plates number 32 (exclusive of the terminal plate); they are without any enlarged spines or tubercles; they are entirely abactinal in position, forming a broad border to the abactinal surface of the disk and rays. Beyond them, when viewed abactinally, project the inferomarginals for about one fifth of their extent, so that from this view the disk and rays have a double-festooned border—an inner broad border formed by the supero-marginal plates, and an outer narrower fringe formed by the uncovered projecting ends of the infero-marginal plates.

The infero-marginal plates correspond, plate to plate, with the supero-marginals; each carries on its projecting abactinad end a tuft of enlarged spinelets, of which about three, usually in an obliquely vertical row, are particularly large; in the interbrachial arcs, as far as the sixth plate, there are usually from two to four additional enlarged spines in a vertical row down the middle of each plate.

The adambulacral plates are large and distant, each bears a palmate furrow-series of about eight long needle-like spinelets, and actinally a radiating rosette-like or paxilla-like group of about twelve very much shorter spinelets. Except that the mouth-plates are a little larger and have slightly larger spines, they are not much modified from the adambulacral type.

The actinal interradial areas are very large; on the disk each area carries about ninety strongly carinated plates arranged in slightly oblique rows; and on the rays similar plates extend in a double series to about the tenth, and in a single series to about the twentieth infero-marginal. In the undenuded state each plate has the appearance of a very large compact and beautifully expanded glomerular paxilla, owing to the fact that the central carina of the plate bears a multitude of stiff radiating spinelets arranged like the florets of a composite flower.

Madreporiform plate very large, entirely concealed by enlarged paxillæ, placed a little nearer to the margin than to the centre. There is a central pore, anal in position, but having, as is seen by dissection, no connexion with the gut.

The tube-feet, which are in two rows, have a simple papillary point.

Andaman Sea, 250 fathoms.

I beg to name this fine species after Mr. Percy Sladen.

Family **Pentagonasteridæ**.

PENTAGONASTER, Linck, Sladen.

21. *Pentagonaster investigatoris*, sp. n.

$R = 1{\cdot}6\,r$. $R = 82{\cdot}5$ millim.

Disk pentagonal, much inflated in the radial, very concave in the interradial areas, flexible; rays very short and broad, flat, pointed, rigid, upturned at the tip.

Abactinal surface covered with uniformly small round tabular plates, which are distinctly isolated from one another and are fringed with a single row of flat squamous membrane-clad granules flush with the general surface, but are otherwise naked, except that some of the plates (perhaps one fourth) bear a very excentric or quite marginal broadly bilobed pedicellaria. Papulæ long, crowded everywhere, except in a narrow band down the middle of each interradial area, where the plates are in close apposition.

Marginal plates 17 in each series from mid-interbrachium to tip of ray, quadrangular, fringed with squamous granules like the abactinal plates, and occasionally bearing a deciduous bilobed pedicellaria; the supero-marginals with a small central patch of deciduous granules, the infero-marginals with a much larger similar patch; at the very tip of the rays these patches of granules are placed on distinct elevations.

Adambulacral plates with a furrow-series of 6 or 7 coarse prism-shaped spinelets, and actinally with (i.) a longitudinal series of three or four large coarse distant granules, one or two of which in a series are often replaced by a bivalve pedicellaria; and (ii.) numerous distant conical granules, arranged in two irregular rows, but sometimes only in one. Mouth-plates large, with the furrow spinelets chisel-shaped, the most central (adoral) one being enlarged.

Actinal interradial areas very large, continued to the tip of the ray; the intermediate plates are rather closely covered with small rounded granules which are more or less deciduous; many of those nearest the actinostome carry one or two rather broadly bilobed pedicellariæ.

Anus excentric. Madreporiform plate of moderate size, placed a third of the way from the centre to the margin, with fine radial striations.

Colour in life brilliant orange.

Bay of Bengal, off the Kistna Delta, 678 fathoms, brown mud.

22. *Pentagonaster arcuatus*, Sladen.

Pentagonaster arcuatus, Sladen, 'Challenger' Asteroidea, p. 277, pl. lii. figs. 1 and 2, pl. xviii. figs. 5 and 6.

I am not quite certain about this determination, although our species conforms exactly to Mr. Sladen's description, and although the habitat supports it—the 'Challenger' specimen being dredged in the green mud of the Japanese Sea at

345 fathoms, and our specimen being dredged in the green mud of the Andaman Sea at 271 fathoms.

23. *Pentagonaster intermedius*, Perrier.

Pentagonaster intermedius, Perrier. Nouv. Archiv. du Mus. d'Hist. Nat. sér. ii. tom. vi., 1883, p. 243, pl. v. fig. 5.

From the Laccadive Sea, off Minnikoy, 1200 fathoms, coral and *Globigerina*-ooze.

Colour in the fresh state salmon-red.

24. *Pentagonaster pulvinus*, sp. n.

Rays 5. R=2·2 *r*. R=33 millim. in the type specimen.

Near *Pentagonaster mirabilis*, Perrier (Arch. Zool. expér. vol. v., 1876, p. 40).

Disk pentagonal, much inflated abactinally and hollowed actinally; rays relatively long and narrow, blunt-pointed, strongly upcurved in the distal half. The strongly convex abactinal surface of disk and rays is covered with hexagonal or polygonal plates, so close-set that, although their boundaries are quite definite, no papulæ are visible on denudation nor any papular pores, and all closely covered with angular granules which show a distinctly paxilliform arrangement; the basal interradial plates are more than twice the size of any of the other abactinal plates.

Marginal plates 17 in the upper, 19 in the lower series, measured from mid-interbrachium to tip of ray, all very closely and uniformly covered with granules except the terminal six to eight in the supero-marginal series, which have a central smooth oval boss.

Adambulacral plates with a furrow-comb of about seven nearly equal-sized lamellar spinelets, and actinally with two longitudinal rows of granules, and between these and the furrow a row of three coarse spinelets, the adcentral (adoral) of which is often replaced by a pedicellaria with two spathulate valves.

Actinal surface deeply concave; the actinal interradial areas are large; the actinal intermediate plates extend to the fourteenth infero-marginal, they are large and roughly quadrangular, and are so closely covered with granules that their limits are not easily discerned.

Anus very indistinct. Madreporiform plate small and also very indistinct; it lies outside a much larger basal interradial plate, and is inconspicuous not merely because it is small, but also because its coarse discontinuous vermicular erosions give it a granular appearance much like that of an ordinary plate.

Colour in the fresh state salmon-red.

Laccadive Sea, off Minnikoy, 1200 fathoms, coral and *Globigerina*-ooze.

MILTELIPHASTER, gen. nov.

Allied to *Calliaster*, Gray.

Rays 5, moderately long.

Abactinal surface of disk and rays covered with a close mosaic of round or hexagonal naked plates, which (like the marginal, adambulacral, and actinal interradial plates) have a fringe of squamous membrane-clad granules lying flush with the surface of the plate, and often carry a single large spike or a large pedicellaria; papulæ conspicuous between the abactinal plates.

Marginal plates large, naked, armed with one or two great spines, which may be sharp or may end in swollen bifid or multifid points; sometimes with a pedicellaria also.

Adambulacral plates with a close comb of furrow-spines, and actinally with (two) great spines which end in swollen multifid points; sometimes with a pedicellaria also.

Actinal interradial areas large, some of the plates with great spines swollen and multifid at tip, or with a pedicellaria.

Madreporiform plate small, nearer to the centre than to the margin of the disk. Anus distinct.

The most characteristic feature of the species upon which this genus is, not without hesitation, established is the curious form of the large spines of the under surface; they end in swollen bifid or multifid points, and, recalling as they do the long spines of certain Cidaroids, may be called incipiently florigerous.

25. *Milteliphaster Wood-Masoni*, sp. n. (Pl. VI. figs. 5–7.)

Rays 5. R = 3·6 *r*. R = 80 millim. in the type specimen.

Disk rather large, very thin, rigid, flat, with slight central and radial abactinal convexities; rays rather long, broad at base, thin, rigid, tapering and gently curving upwards from base to tip, the tip being turned right over.

Abactinal surface closely covered with quite smooth, naked, circular, oval, or hexagonal plates, which are fringed with a single close series of small squamous membrane-clad granules lying nearly flush with the general surface; the central plates and the mid-radial plates to a point about halfway along the ray are much enlarged, and usually bear a central large coarse erect spine from 5 to 8 millim. in length, and often also a large excentric pedicellaria formed of two short-stalked spoons or obovate leaves; the plates elsewhere are small and occasionally carry a pedicellaria, but never a spine; papulæ emerge everywhere between the plates, but much more numerously in the centre and along the margin of the disk.

Marginal plates quite smooth, edged like the abactinal plates with squamous granules.

The supero-marginal plates number 20, excluding the globular terminal plate, and are entirely lateral and vertical throughout; they are tumid, and each carries at its abactinad end a large coarse sharp spine, from 5 to 9 millim. long, standing rigidly outwards almost at right angles to the ray; at the tip of the ray the plates have two spines; many of the plates have also one of the large pedicellariæ formed of two spoons or obovate leaves.

The infero-marginals correspond plate to plate with the supero-marginals in the interbrachial arcs, but not in the distal half of the ray; each bears on a central eroded eminence one or two, occasionally three, coarse spines, not quite so long as those of the supero-marginal series, and differing from them in having the points bifid or trifid; a few of the plates carry also one of the large obovate pedicellariæ.

The adambulacral plates, which, in addition to the edging of squamous membrane-clad granules, have a distantly granular surface, bear a furrow-comb of eight to ten close truncate spinelets, and actinally a transversely arranged pair of large spines (Pl. VI. fig. 7) equal in length to those of the infero-marginal series, and, somewhat like them, ending in swollen multifid points not unlike the long spines of *Dorocidaris bracteata* or of *Goniocidaris florigera*; a few of the plates have also one of the large pedicellariæ. Mouth-plates with the central (adoral) furrow-spine enlarged—4 millim. long in the type specimen—and each with one large "florigerous" spine actinally.

Actinal interradial areas large, extending to the eighth infero-marginal plate; the actinal intermediate plates are arranged in concentric chevrons or semicircles, in addition to the edging of squamous granules they often have an incomplete second marginal series of granules, and occasionally either a central large "florigerous" spine or a large obovate pedicellaria.

Anus central. Madreporiform plate small, radially striated, placed a little nearer to the centre than to the margin.

Colour in life a network of cinnabar-red on a yellow ground abactinally.

Andaman Sea, 230 to 290 fathoms.

I have named this magnificent species after its discoverer.

DORIGONA, Gray.

26. *Dorigona pentaphylla*, sp. n.

A magnificent species, very near to *Dorigona longimana*, Möbius.

Rays 5. R=3·25 *r*. R=115 millim. in the
type specimen.

Disk large, flat, pentagonal; rays long, broad at base, tapering. All the plates—actinal, marginal, and abactinal—except the adambulacral perfectly smooth and edged with foliaceous granules lying flush with the general surface.

Abactinal surface of the rays entirely occupied by the supero-marginal plates, which from the seventh onward meet across the ray; abactinal surface of the disk covered with hexagonal plates, of which those in a broadly oval petal-shaped area in each radius are distant regular hexagons—in the mid-radial line of predominant size—with long tentacle-like papulæ standing near the angles, while those in a triangular area in each interradius are crowded irregular hexagons without any papulæ intervening.

The marginal plates number about 30 in each series, measured from mid-interbrachium to tip of ray; they are broad massive squares and form a broad margin on both surfaces; the supero-marginals from and including the seventh meet across the ray in a zigzag suture; the infero-marginals are smaller than the supero-marginals and alternate with them, except in the interbrachia, where the two series nearly correspond.

The adambulacral plates are small; each has a semicircular furrow-series of small foliaceous spinelets—ten or eleven in number in the basal half, eight to six in number in the apical half of the ray—of which those at the ends of the series are thickened, while actinally there are three irregular longitudinal rows of depressed granules; most of the plates near the actinostomal end have a central bivalve or trivalve pedicellaria. On the mouth-plates the furrow spines become more prism-shaped.

Actinal interradial areas very large, the intermediate plates extending to about the fourteenth infero-marginal; the plates, which number about 250 in each area, are arranged in about nine chevrons, and decrease conspicuously in size from actinostome to margin and from ambulacrum to mid-interbrachium.

Madreporiform plate pentagonal, with fine radial striations, placed not quite a third of the way from the centre to the margin of the disk.

Tube-feet with a broad sucker.

Colour in alcohol ivory-white, the papular areas combining to form a beautifully symmetrical, dark-coloured, five-petal flower.

Andaman Sea, 271 fathoms.

NYMPHASTER, Sladen.

27. *Nymphaster florifer*, sp. n.

Rays 5. R=3 *r*. R=32 millim. in the type specimen.

Disk pentagonal, large, very thin and flat; rays of moderate length, very narrow and flat, quadrangular in section; interbrachial arcs wide.

Abactinal surface of the disk displaying in the centre and in the radial areas a large and particularly beautiful and conspicuous rosette of hexagonal paxilliform plates, each inflated petal-shaped segment of the rosette consisting of seven longitudinal rows of plates, of which those in the middle row —coinciding with the mid-radial axis—are of predominant size; the interradial (interpetaloid) areas are small and triangular and are clothed with small irregularly pentagonal or subcircular plates.

The abactinal surface of the rays, between the plates of the supero-marginal series, is occupied chiefly by a continuation of the large plates, now become rather irregular in shape, of the middle row of the petals, with on each side a discontinuous row of platelets.

The hexagonal plates of the rosette are true paxillæ and consist of a raised tabulum bearing in the centre from one to six (usually two or three) and round the margin from twelve to sixteen flat-topped bacillary granules; the irregular plates of the interradial (interpetaloid) areas and of the rays are merely covered with minute granules.

The marginal plates are large and rectangular and are uniformly covered with small granules, without any other armature; many of them bear an entrenched pedicellaria, found only on denudation; they number about twenty-two in each series, which correspond plate to plate; the superomarginals do not meet across the ray even at its very tip.

The adambulacral plates have a pectinate furrow-series of seven to eight long fine spinelets of nearly equal size, the proximal (adoral) one of the series alone being diminutive, and actinally a row of from three to five papillary spinelets, and outside these a row of four or five granules. Mouth-plates small, the conjoint pair nearly circular in outline, the armature hardly differing from the adambulacral type except that the granules are more numerous.

Actinal interradial areas large, each area carrying about sixty irregularly quadrangular plates arranged in chevron series; all of these plates are granular like the marginal plates, and many of those nearest the ambulacrum have an entrenched pedicellaria.

Madreporiform plate small but conspicuous, placed very much nearer to the centre than to the margin of the disk.

The papulæ are found only in the rosette of the abactinal surface, where they stand with great regularity at the angles of the hexagonal plates.

Andaman Sea, 130 to 250 fathoms.

This species much resembles *Nymphaster bipunctus*, Sladen.

In young specimens R = about 2·2 *r*, the interbrachial arcs are not so wide as they are in the adult, the apical plates are conspicuously large, and the marginal plates number eight or nine in each series.

28. *Nymphaster protentus*, Sladen.

Nymphaster protentus, Sladen, 'Challenger' Asteroidea, p. 303, pl. l. figs. 3 and 4, pl. liii. figs. 9 and 10.

Andaman Sea, 220 to 250 fathoms.

29. *Nymphaster basilicus*, Sladen.

Nymphaster basilicus, Sladen, 'Challenger' Asteroidea, p. 308, pl. lvii. figs. 8 and 9.

Two fine specimens, one from the Laccadive Sea, 1370 fathoms, coral-mud, the other from the Gulf of Manaar, 597 fathoms, green mud.

This species, as Mr. Sladen observes, appears to be very near *Dorigona ternalis*, E. Perrier.

30. *Nymphaster nora*, sp. n.

Rays 5. R = 6·3 *r*. R = 120 millim. in the
type specimen.

Disk small, flat, pentagonal; rays very long and slender and tapering, quadrangular in section, but at the tip cylindrical; interbrachial arcs wide.

Abactinal area of the rays entirely occupied by the supero-marginal plates, which from the fifth onwards meet across the ray; abactinal area of the disk covered with hexagonal paxilliform plates, which consist of a slightly raised tabulum closely covered with angular many-facetted granules, of which six to nine form a central group and twelve to sixteen a marginal ring; of these plates the basal interradials are the largest, but those in the radial areas, especially those in the mid-radial line, are also very large; papulæ are found in the radial areas only, emerging at the angles of the plates.

The marginal plates number about 40 in each series, they are quadrangular and massive, and are closely covered with angular granules without any other armature; each supero-marginal articulates with two infero-marginals unequally.

The supero-marginals of opposite sides, from the fifth onward, meet across the ray, plate to plate, in a straight suture; each plate presents a broad abactinal plane and a narrow lateral plane, and at the junction of these two planes an inflated angle; the cap-like terminal plate bears five spines in a half hoop.

The infero-marginals are smaller than the supero-marginals; their lateral surface, except in the interbrachium, is twice the breadth of the actinal surface, and the angle at which the two surfaces meet is so inflated that the rays, whether viewed actinally or abactinally, seem to have beaded or festooned borders.

The large adambulacral plates completely close the furrow, the distantly isolated pairs of tube-feet emerging from semicircular gaps which, by the close apposition of the plates of opposite sides, become isolated circular holes. Each adambulacral plate is, in fact, rudely L-shaped, the broad horizontal limbs of the L's meeting across the furrow, and the much restricted concavities of the L's forming the gaps which, by the apposition of the plates, are converted into closed chambers; actinally the plates are closely covered with granules, while on the furrow-edge each plate has about twelve long compressed spinelets arranged (except in the case of a few plates close to the actinostome) in two divergent series so as to form a circular palisade round each isolated pair of tube-feet.

Actinal interradial areas large, the irregularly quadrangular and closely granular intermediate plates being arranged in concentric chevrons and numbering about fifty in each area.

Madreporiform plate very small, with coarse radiating striations; placed close to the centre, encircled by three much larger plates, the adcentral of which—the largest of all—is a basal interradial.

Andaman Sea, 490 fathoms.

Paragonaster, Sladen.

31. *Paragonaster tenuiradiis*, sp. n.

Rays 5. R=4·5 *r*. R=40 millim. in the type specimen.

Disk small, pentagonal; rays long, extremely slender, oval in section, rigid.

The abactinal area of the small disk bears large crowded paxilliform plates arranged in regular chevrons and closely covered with angular flat-topped granules, the mid-radial plates being the largest and the mid-interradial plates the smallest of all; the narrow abactinal surface of the rays bears a single series of narrow granular plates intervening between the supero-marginal plates of opposite sides.

The marginal plates, which are large and closely covered with angular granules, number over twenty-five in each series; the supero-marginals, which are a good deal larger than the infero-marginals, are almost entirely lateral on the disk, but largely abactinal on the rays, where those of opposite sides are separated only by a narrow series of abactinal plates; the infero-marginals alternate (more markedly in the distal half of the ray, less markedly in the interbrachia) with the supero-marginals, and those in the interbrachia bear a median vertical series of two to four small spines or spinelets.

The adambulacral plates bear a semicircular marginal series of nine or ten radiating spinelets encircling a few distant actinally-placed spinelets, of which one, standing close to the middle of the marginal series, is more conspicuous than the rest. Mouth-plates prominent actinally, with a close furrow-series of ten or eleven spinelets and a single suture-series of nine or ten spinelets.

Actinal interradial areas small, barely reaching to the third infero-marginal plate; in each area there are about thirty minute scale-like plates bearing distant papilliform granules.

Madreporiform plate completely hidden. Anus central.

Colour in the fresh state pale yellowish pink.

Bay of Bengal, 1748 fathoms, *Globigerina*-ooze and pumice.

32. *Paragonaster*, sp.

Paragonaster, sp., Ann. & Mag. Nat. Hist., Dec. 1891, p. 436.

A specimen too much mutilated for description was taken with the above; it is characterized by having the papulæ in distinctly circumscribed papularia, over which the paxillæ are singularly large and prominent.

MEDIASTER, Stimpson.

33. *Mediaster roseus*, sp. n.

Mediaster, sp., Ann. & Mag. Nat. Hist., Jan. 1891, p. 13.

Rays 5. R=4 *r*. R=42 millim. in the type specimen.

Disk small, flat; rays flat, tapering, rigid.

Abactinal surface of the disk covered with paxilliform plates which in the centre and interradii are small, irregular in shape, and crowded together, but which in the radial areas are large and regularly hexagonal and are arranged in regular longitudinal parallel rows; the plates are surmounted by large flat-topped hexagonal granules of unequal size, which fit close together to form a mosaic for each separate plate; abactinal surface of the rays formed principally by the supero-marginal plates, which, however, are separated throughout the ray by at least three rows of small irregularly hexagonal paxilliform plates.

Marginal plates massive, closely covered with hexagonal flat-topped granules, and forming on both aspects a very broad border to the disk and rays; they number thirty-five in each series, and the two series correspond plate to plate; the infero-marginals of the interbrachia have a median vertical series of distant papilliform spinelets or pedicellariæ.

The large adambulacral plates have each a radiating furrow-series of seven or eight flattened prismatic spinelets, slightly decreasing in size in each series from the ends to the middle, and actinally three unequal longitudinal series of close prismatic granules. Mouth-plates narrow and elongate, each with a furrow-series and a suture-series of coarse papilliform spinelets, which increase in size from periphery to centre.

Actinal interradial areas small, semielliptical in shape, reaching to the third infero-marginal plate; about thirty plates in each area, of which those in the row nearest the ambulacrum are much the largest; all the plates are closely covered with prismatic granules, grouped, except in the particularly large adoral pair of plates, in paxilla-form.

Anus central but indistinct. Madreporiform plate almost completely hidden, rather nearer to the marginal plates than to the centre.

Ambulacral furrow narrow.

Colour in the fresh state light pink.

Laccadive Sea, 740 fathoms, coral-mud.

This species appears to be closely related to *Astrogonium fallax,* Perrier (Ann. Sci. Nat. tom. xix., 1885). Guided by the work of Mr. Sladen and by the description and figures in the 'Boston Journal of Natural History,' vol. vi., 1857, p. 530, pl. xxiii., I have placed it, though not without misgiving, in Stimpson's Pacific genus.

ANTHENOIDES, Perrier.

34. *Anthenoides sarissa*, sp. n.

Rays 5. R=2·5 *r*. R=46 millim. in the type specimen.

Disk large, flexible, inflatable, especially in the interradial areas; rays moderately long, rigid, broad at base, but quickly becoming narrow and then tapering.

The abactinal surface of the disk and of the rays, except at the extreme tip, where the supero-marginal plates meet across, is cased by flat plates which are covered with a finely and distantly granulose membrane; these plates are of two kinds and of two modes of disposition:—(i.) large stellate or somewhat polygonal plates arranged in series radiating from the centre of the disk, and (ii.) small or minute platelets inlaid everywhere between the large plates. Papulæ emerge in the seams between the plates everywhere except in a narrow band in each interradius.

The marginal plates, which number about 20 in each series, are large and finely and distantly granular. The supero-marginals form a very broad bevelled margin to the disk in the interradii and a narrower margin to the rays, except in the distal third of the latter, where they nearly meet across the ray; except for one, two, or three small inconstant papilliform pedicellariæ occurring on the extreme distal edge of the plates of the apical half of the ray they are unarmed, but the cap-like terminal plate has a fringe of five spinelets. The infero-marginals, which correspond plate to plate with the supero-marginals, have each a strong lateral bulge on which stands a horizontal series of three (sometimes only two) spines, but in the apical half of the rays there is only one spine, placed on the extreme distal edge of the plate.

The small adambulacral plates have each a palmate furrow-series of six or seven spinelets, and almost in serial continuity with these, and to the central (adoral) side of them, a pedicellaria with two long spoon-shaped valves; actinally each plate has near its distal end an eminence on which stands a stout spine longer than the plate itself and usually longer than any of the infero-marginal spines, in addition to two or three pustules; on the mouth-plates, which are extremely prominent actinally, the spine and pedicellaria are usually absent, and only the pustular granules present, but the central (adoral) furrow-spines are much enlarged.

The actinal interradial areas are very large, reaching to the sixth or seventh infero-marginal (thirteenth or fourteenth adambulacral) plates; each area bears eighty to ninety large plates arranged in concentric chevrons; all the plates are covered with a distantly granular membrane, and some or all of them (but most constantly those of the series next the ambulacrum) bear one or more papilliform pedicellariæ; the plates of the second series from the ambulacrum are of superior size.

Anus central, distinct. Madreporiform plate large, with fine radial striations; placed rather nearer to the centre than to the margin.

Ambulacral furrow wide; tube-feet with a terminal sucker.

Andaman Sea, 130 to 250 fathoms.

Family **Asterinidæ**.

PALMIPES, Linck.

35. *Palmipes pellucidus*, sp. n.

Rays 5. R=1·5 *r*. R=48 millim. in the type specimen.

Form a curvilinear pentagon with bluntly rounded angles; flat, very thin and leaf-like, membranous, semitransparent.

Abactinal surface with regular longitudinal and oblique rows of scale-like rhomboid or subhexagonal plates, which gradually diminish in size from the centre to the margin; all the plates are covered with distant erect spicules and bear each a central tuft of capillary spinelets, the tufts and their constituent spinelets being enlarged in a mid-radial row. The papulæ are in *four* rows, two on each side of the mid-radial line, the inner row on each side extending from the centre of the disk to the tip of the ray, and the outer extending continuously only about halfway along the ray, and thence onward in a broken series. In young specimens there are only two rows of papulæ, one on each side of the mid-radial line.

The papular pores, like the papulæ themselves, are of two kinds; all are encircled by a close palisade of spinelets, but from three to six of the pores of the inner two rows are much enlarged, to give exit each to a singularly long papula, and these are encircled by spinelets of superior length; the small pores give exit each to a small short papula.

The marginal plates, which lie in alternation with the oblique rows of abactinal plates, are minute, and each is edged with a tuft of spinelets and each has a very minute scale-like platelet at its base.

The adambulacral plates have each a palmate furrow-series of six spinelets and actinally an oblique or curved series of three or four capillary spinelets; the mouth-plates have a furrow-series of eight or nine spinelets which increase in size adorally and a suture-series of five or six capillary spinelets.

The actinal plates are in regular longitudinal and oblique rows, and diminish in size from the actinostome to the margin; each plate carries a radiating marginal series of capillary spinelets, four in a series near the actinostome, three elsewhere.

Colour in life pellucid hyaline grey.

Andaman Sea, 112 fathoms, blue mud.

Family **Linckiidæ.**

Chætaster, M. & T.

36. *Chætaster*, sp.

In our collection there is a small broken specimen of an undoubted *Chætaster* which I do not at present venture to describe. In appearance it corresponds with the figure of *Chætaster munitus*, Möbius (‘Neue Seesterne des Hamburger und Kieler Museums,’ pl. i. figs. 1 and 2), and, so far as the description (*op. cit.* p. 3) of that species goes (a description which, however, is certainly incomplete), it corresponds with it exactly. With Professor Möbius’s form I should have identified our species, had not *Chætaster munitus*, Möbius, been pronounced by Mr. Sladen to be merely a synonym of *Nectria ocellifera* (Lamarck).

The single specimen is from the Andaman Sea, 238 to 290 fathoms.

Family **Zoroasteridæ.**

ZOROASTER, Wyville Thomson.

37. *Zoroaster Alfredi*, sp. n.

Rays 5. R = 9 *r*. R = about 190 millim. in the type specimen.

Disk small, hemispherical, tumid above the tumid rays; rays long, narrow, tapering, subcylindrical to cylindrical.

Abactinal surface of disk with large distant, subhexagonal, or substellate primary radials and interradials surrounding a large dorso-central plate, and with numerous small intervening plates; all the plates are closely covered with simple or grooved or bifid membrane-clad spinelets, and the large hollows between neighbouring plates contain each a group of papulæ and a group of pedicellariæ, one of which is of conspicuous size, being about as big as a grape-stone.

The rays have a longitudinal mid-radial row of large subhexagonal plates co-serial with the large primary plate of the apical system, and on each side of it and parallel with it six (in the interbrachia seven, at the end of the rays five) rows of smaller plates, which also form transversely parallel series, the lowest row articulating with the cramped adambulacrals; all these plates are closely covered with simple or grooved membrane-clad spinelets and pedicellariæ, and bear a centrally-placed spine, which is small, erect, and often obsolescent in the plates of the abactinal rows, but large and acumbent in the four lower rows on each side, gradually increasing in size from above downwards; the large hollow intervals between neighbouring plates, which, in consequence of the symmetry of the plates themselves, also fall into longitudinally and transversely parallel series, contain groups of pedicellariæ, one of which in each group is conspicuously enlarged, and (except between the lowermost two rows of plates) from one to three papulæ.

The adambulacral plates extend vertically far upwards into the furrow, and the whole system is so cramped that the two middle tube-feet of each row are quite perceptibly atrophied by pressure; every alternate plate has a strongly salient intra-ambulacral ridge, upon which stands a row of three or four large spinelets, each with a large pedicellaria and often also a bunch of small pedicellariæ attached by ligament to its base, and which, deep in the roof of the furrow, bifurcates to give origin to a pair of large bunches of pedicellariæ, twelve to twenty in each bunch; all the adambulacral plates are covered with spinelets and small pedicellariæ on their narrow actinal edge.

Madreporiform plate large, with coarsish radial striations.

Colour in the fresh state "deep salmon-colour throughout, spines a little paler" (*G. M. Giles*).

Bay of Bengal, 1300 to 1380 fathoms, *Globigerina*-ooze.

This large and very beautiful species is readily distinguished by the extraordinary development of its pedicellariæ, especially by the two large cæspitose masses of these organs which are borne on every alternate adambulacral plate between the bases of the tube-feet, and by the large pedicellariæ (much more conspicuous than any of the spines except those on the plates of the two most actinal rows) arranged in regular longitudinal and transverse parallel series along the rays.

It was named by Messrs. Wood-Mason and Giles after Commander Alfred Carpenter, R.N.

38. *Zoroaster Barathri*, sp. n.

Rays 5. R=16 *r*. R=about 180 millim. in the type specimen.

Disk extremely small, not differentiated from the bases of the rays, tumid; rays extremely long and finely tapering, semicylindrical.

Abactinal surface of disk with large, close-set, subhexagonal primary radials and interradials surrounding an apical mass formed of a dorso-central and radial underbasal plates, all of equal size; all the plates are very closely covered with capillary spines, and the small depressions which intervene between the plates are perforated for one or two papulæ and bear from one to three pedicellariæ, of which one is sometimes slightly enlarged.

The rays have a longitudinal mid-radial row of large tumid hexagonal plates coserial with the large primary radial, and on each side of it six (in the interbrachia seven, at the end of the rays five) parallel rows of smaller plates, very close-set, the lowest row abutting on the adambulacrals; these plates also fall into close-set transversely parallel series, and all are densely covered with capillary spines that become gradually longer and more slender in each successive row from the abactinal to the actinal surface; the plates of the lowest (most actinad) two or three rows bear each one or two centrally-placed spines which are of slightly superior size. The small intervals between the angles of the closely apposed plates give exit, except between the two lowermost (most actinad) rows, each to a papula, and (on the plates) between every two papulæ is a pedicellaria.

The adambulacral plates are short and do not extend far up into the furrow; each plate bears on its actinal edge a transverse row of two or three large sabre-shaped spinelets, of which the innermost often carries a large pedicellaria, and every alternate plate has also a prominent intra-ambulacral ridge, on which stand two more spines, of which the outer carries a pedicellaria almost as large and conspicuous as a tube-foot and the inner a small cluster of small pedicellariæ. The mouth-plates bear each two series of long needle-like spines.

Tube-feet quadriserial.

Madreporiform plate very small and much hidden, with a deep, coarse, vermicular sculpture like a peach-stone.

Bay of Bengal, 1520 fathoms, *Globigerina*-ooze.

This fine species is recognized (i.) by its extremely small disk not differentiated from the bases of the rays, and (ii.) by the close capillary spinulation of the plates, which gives the animal a uniformly hairy appearance when dried. It appears to be more nearly related to *Zoroaster longicauda*, Perrier, than to any other described species.

39. *Zoroaster planus*, sp. n.

Rays 5. R=16 *r*. R=210 millim. in the type specimen.

Disk extremely small, depressed; rays extremely long and finely tapering, semicylindrical, depressed.

Abactinal surface of disk with slightly enlarged, close-set, subhexagonal, primary radials and interradials surrounding a mass composed of a dorso-central and radial under-basal plates all of equal size; all the plates are rather closely covered with capillary spinelets, and the dorso-central and the radial plates carry in addition a stout conical fluted spine; the narrow intervals between neighbouring plates each with one papula and often with a single large pedicellaria.

The rays have a longitudinal mid-radial row of large tumid plates, each of which bears, besides the capillary spinelets, a central stout, conical, fluted spine much like a pedicellaria;

on each side of this row are six (seven in the interbrachia, five at the end of the rays) very close parallel rows of smaller plates, the lowest row articulating with the adambulacrals; these plates, which also fall into transversely parallel series, are rather distantly covered with capillary spinelets, the central one of which in each plate (except in the row immediately adjoining the large mid-radial series) becomes a long slender spine that gradually increases in size in each successive row from the abactinal to the actinal surface. The narrow intervals between the angles of neighbouring plates give passage (except between the two lowermost rows of plates) each to one papula, and (on the plates) between the papulæ is a rather large pedicellaria.

The adambulacral plates are short and do not extend far upwards within the furrow; each plate bears on its actinal edge two transversely placed spinelets and occasionally a pedicellaria, and every alternate plate has a prominent intra-ambulacral ridge on which is borne a row of three spinelets, the innermost being furnished with a cluster of eight small pedicellariæ, and the one next the innermost with a single large pedicellaria. The mouth-plates are armed with large needle-like spines.

Tube-feet quadriserial.

Madreporiform plate large, tumid, and conspicuous, with a coarse peach-stone sculpture.

Colour in life salmon-red.

Laccadive Sea, 1200 fathoms, coral and *Globigerina*-ooze.

This species is very like *Z. Barathri*, from which it is easily distinguished, (i.) by the flattened disk very definitely delimited from the bases of the rays; (ii.) by the large salient madreporiform plate; and (iii.) by the large spinelet borne centrally on every plate except the basal interradials and the plates of the row immediately adjoining the mid-radial row on each side.

40. *Zoroaster angulatus*, sp. n.

Rays 5. R=12 to 13 *r*. R=148 millim. in the type specimen.

Disk small, high, flat-topped; rays long and tapering, high, compressed, and strongly keeled abactinally.

Abactinal surface of disk with close-set, large, tumid, stellate primary radials and basals surrounding a very large tumid dorso-central plate and a ring of small depressed radial under-basals; all the plates bearing distant capillary spinelets and small marginal pedicellariæ, and the crevices between the plates giving exit to scattered distant papulæ.

The rays with a longitudinal mid-radial row of very large tumid vertebra-shaped plates co-serial with the primary radial, each bearing a central globular or squatly conical spine; and on each side of this mid-radial row seven (in the distal half of the ray six) parallel rows of much smaller tumid octagonal plates, the lowermost of which articulates with the adambulacrals; these plates, which also fall into transversely parallel series, all bear distant capillary spinelets and small marginal pedicellariæ, and all but those in the row immediately adjoining the mid-radial row have a central long needle-like spine, which is largest in the plates of the row adjoining the adambulacrals. The pin-hole intervals between the angles of neighbouring plates (except between the two lowermost rows of plates) are just large enough to give exit to a single small papula.

Adambulacral plates small, almost cylindrical; each plate bears on its actinal surface either three or four long sharp spinelets in two transverse series, one of the spinelets which adjoins the furrow often furnished with one or two small pedicellariæ; every alternate plate has a prominent intra-ambulacral ridge, on which stands a row of two or three long spinelets, of which the innermost bears a cluster of from six to ten small pedicellariæ and the outermost a single large pedicellaria. The mouth-plates are armed with needle-like spines similar to those of the other adambulacral plates.

Tube-feet quadriserial, but the two middle feet of each row reduced in size.

Madreporiform plate very small, not half the size of the basal plate, outside of which it lies almost hidden by overhanging spinelets.

Gulf of Manaar, 597 fathoms, green mud; Laccadive Sea, 705 fathoms, coarse coral shingle.

This species is distinguished, (i.) by the high but flat-topped disk, with its tumid stellate primary plates sparsely covered with spinelets; (ii.) by the strongly carinated rays, pentagonal in section, with their median row of large vertebra-shaped plates; and (iii.) by the broad cylindrical adambulacral plates with their two transverse series of actinal spinelets.

In a young specimen the disk, with its relatively enormous tumid apical plates, recalls the appearance of the Ophiuroid *Ophiomastus*; the relatively short rays ($R=8\,r$) end in a large inflated, helmet-like, two-horned plate, and the tube-feet are biserial.

41. *Zoroaster carinatus*, sp. n.

Rays 5. R=about 10 *r*. R=about 90 millim. in the type specimen.

Disk small, hemispherical, higher than the rays; rays semicylindrical, strongly carinated, tapering in the distal half, but not much diminishing in the basal half.

Abactinal surface of disk with close-set, large, tumid, stellate, primary radials and basals surrounding a very prominent dorso-central plate and a ring of small depressed underbasals; all the plates are densely covered with thorn-like spinelets, which are enlarged in the middle of the plate; isolated papulæ surround the plates, and a few small scattered pedicellariæ occur.

Rays with a median longitudinal row of very large and tumid stellate plates, closely covered with spinelets, of which those in a tuft in the middle of each plate are enlarged. On each side of this median row is a depressed discontinuous series of very small irregular platelets, below which are five parallel rows of close-set tumid octagonal plates; all these are closely covered with thorn-like spinelets, and those of the four lower rows have also a long slender median spine. The minute apertures between the angles of neighbouring plates (except between those of the two lowermost rows) give exit to a single papula, and close to every papula is a small pedicellaria.

Adambulacral plates small, cylindrical, each with a transverse series of two (rarely three) long slender spinelets; every alternate plate has a prominent intra-ambulacral ridge bearing a row of two or (usually) three similar but larger spinelets, one of which, within the furrow, has occasionally a small pedicellaria, or sometimes two. Mouth-plates with long spinelets like those of the ordinary adambulacrals.

Tube-feet quadriserial.

Madreporiform plate very small, hardly one third the size of the basal plate outside of which it lies.

Colour in life brick-red.

Andaman Sea, 130 to 250 fathoms.

This species, which is one of the commonest starfishes met with in the Andaman Sea between 200 and 300 fathoms, is characterized, (i.) by the dense thorny armature of the very tumid apical plates, each of which has a central tuft of enlarged spinelets; (ii.) by the strong carination of the rays, which is due partly to the tufts of enlarged spinelets of the tumid mid-radial row of plates and partly to the sinking of the small plates on each side of this prominent mid-radial row; and (iii.) by the paucity of pedicellariæ, even the spines of the adambulacral plates being oftener without these organs than with them.

In the young stage ($R = 6{\cdot}5\,r$) the apical and abactinal mid-radial plates are extremely prominent, the tip of the rays is capped by a large, inflated, spiny terminal plate, and the tube-feet are but indistinctly quadriserial.

42. *Zoroaster Gilesii*, sp. n.

Rays 5. $R =$ about $8\,r$. $R = 70$ millim.

Disk comparatively large, low, flat or very gently convex, very distinctly delimited from the rays (above which it is not much elevated) by a complete ring of massive semiglobular plates; abactinally it is encased in concentric series of these great semiglobular plates (with or without small sunken plates intervening) in the following order:—a dorso-central, five basal interradials, five primary radials (the largest of all), and twenty-five marginal plates, of which one succeeds each primary radial and four close in each interradial area. All the plates are covered with capillary spinelets with a few coarser spinelets interspersed, and the intervals between the plates are occupied by papulæ and rather numerous large pedicellariæ.

The rays are rigid, broadish, and flat, with a gentle abactinal convexity, and are encased in thirteen longitudinal parallel series of small and very close-set tumid plates, which also stand in obliquely transverse parallel series. These plates have the following arrangement:—(i.) a mid-radial row of suboctagonal slightly imbricating plates lying in a furrow between two rows of distant papulæ (which two rows of papulæ are the only papulæ present on the rays), flanked on each side by (ii.) six rows of very close-set bead-like plates, of which the upper (abactinad) three rows are much the larger, the lower (actinad) three rows consisting of minute plates so crowded together as to appear at first sight like a single row. All these plates are covered with coarse spinelets, which are larger and denser in the three lower (actinad) rows, and those of the mid-radial and three upper (abactinad) rows on each side have also a small coarse spine centrally, and on each suture margin a largish pedicellaria, while those of the three lower rows have each a long lanceolate spine.

Adambulacral plates small and short, but extending high up into the furrow; each plate has two transversely placed spinelets, and every alternate plate has a prominent intra-ambulacral ridge bearing a row of three spines, the innermost of which carries a single large pedicellaria. Mouth-plates armed with spines similar to those of the ordinary adambulacrals.

Tube-feet quadriserial.

Madreporiform plate small and much hidden by neighbouring spinelets, with obsolescent sculpture.

Colour in life "red ochre" (*G. M. Giles*).

Andaman Sea, 490 to 500 fathoms.

43. *Zoroaster squameus*, sp. n.

Rays 5. R = about 11 *r*. R = 135 millim. in the type specimen.

Disk pentagonal, flat-topped, distinctly delimited from the rays by a circumferential series of large tumid plates; its abactinal surface bears concentric series of massive tumid stellate plates—a dorso-central, five basal interradials, five primary radials (the largest of all), and twenty-five marginals arranged as in *Z. Gilesii*; all these plates bear distant deciduous granules, and the intervals between them display papulæ and numerous small pedicellariæ.

Rays long, tapering, compressed, strongly convex abactinally, with thirteen to fifteen parallel longitudinal rows of plates (which also fall into transversely parallel series), each row, with the exception of the mid-radial row, strongly imbricate over the row below. The following is their arrangement:—(i.) a mid-radial row of non-imbricate plates, hardly enlarged, and flush with the surface of the ray; flanked on each side by (ii.) six or seven rows of scale-like plates which overlap one another from above like tiles on a roof, those of the upper four rows being the more massive and conspicuous, those of the lower two or three rows being thin and crushed up beneath one another. The mid-radial row of plates appears to be quite smooth and unarmed; the plates of the three or four upper (abactinad) rows on each side are quite smooth, but bear each a more or less deciduous procumbent median spine, and in the distal half of the ray some marginal pedicellariæ; the plates of the three lower (actinad) rows on each side are very closely covered with acumbent scale-like spinelets, with a long procumbent, needle-like, deciduous median spine. Papulæ occur, accompanied each by a pedicellaria, in an incompletely double row on each side of the mid-radial row of plates; and between the second and third row of plates throughout the ray, and between the third and fourth row of plates in the basal fourth of the ray, there are minute perforations (seen only in the dried specimen) which appear to be too small for the passage of papulæ.

Adambulacral plates very small, but extending high up into the furrow; each plate has two short transverse series of spinelets, and every alternate plate has a prominent intra-ambulacral ridge bearing three stout spinelets, of which the innermost is furnished with a large pedicellaria emerging from a cluster of small pedicellariæ. Mouth-plates with long needle-like spines and large clusters of pedicellariæ.

Tube-feet quadriserial.

Madreporiform plate very small, with coarse peach-stone sculpturing.

Colour in life orange-pink.

Laccadive Sea, 1043 fathoms, green mud.

44. *Zoroaster zea*, sp. n.

Rays 5. R=about 12 *r*. R=144 millim. in the type specimen.

Disk semicircular, flat-topped, well raised above the rays, from which it is delimited by a circumferential series of massive oval or substellate plates, arranged exactly as in *Z. Gilesii* and *Z. squameus*, with small plates intervening. All the plates are quite smooth and membrane-clad, but the small intervening plates bear each a small coarse spine; the intervals between the plates show distant papulæ and pedicellariæ, the last often in pairs.

Rays long, rigid, subcylindrical, tapering, with thirteen longitudinal parallel series of Indian-corn-like or bead-like membrane-clad plates, which also fall into transversely parallel series. A single ray, viewed abactinally, has much the appearance of a seed-spike of maize. The plates are disposed as follows:—(i.) a mid-radial row of slightly enlarged plates, flanked on each side by a deep furrow, in which lies (ii.) a discontinuous row of minute platelets concealed by membrane, and only revealed either by a small pedicellaria or by a coarse spikelet which they sometimes bear; and outside these (iii.) six rows of plates, decreasing in size and inclining to imbricate actinally, of which the three abactinad rows are, like the mid-radial row, quite naked and unarmed, while the three actinad rows are thickly covered with membrane-clad squamous spinelets and bear a median spine and sometimes a marginal pedicellaria. Long papulæ are found in a close double row in the furrow on each side of the mid-radial series of plates; minute perforations occur between some of the other rows of plates, but they are only visible with a lens, and seem to be far too small to give exit to papulæ.

The adambulacral plates are covered with flat foliaceous spinelets; every alternate plate has a prominent intra-ambulacral ridge bearing a row of three sabre-shaped spines, and deep within the furrow a slender spinelet furnished with several pedicellariæ, one of which is large. Mouth-plates with stout spinelets and clusters of pedicellariæ.

Tube-feet quadriserial.

Madreporiform plate small—half the size of a basal interradial plate—but tumid and conspicuous, with coarse radial striations.

Gulf of Manaar, 597 fathoms, green mud; Laccadive Sea, 1200 fathoms, coral and *Globigerina*-ooze.

In a youngish specimen (R=65 millim.) R=about 8 *r*; the mid-radial plates are relatively larger; the rays terminate in a rather inflated bilobed plate fringed with spines; and the papulæ, which are in a double row on each side of the mid-radial series of plates, extend only about halfway along the rays.

Zoroaster Gilesii, *Z. squameus*, and *Z. zea* form a very well-defined group within the genus *Zoroaster*, and, along with *Z. Sigsbeei*, Perrier (Nouv. Archiv. du Mus. sér. ii. vol. vi., 1883, p. 195, pl. iii. fig. 2), may perhaps be conveniently recognized as a subgenus. The following characters are common to the first three species, and, as far as can be judged from the rather brief though very succinct description of Professor Perrier and from the phototype figure, appear to be shared by the last:—(i.) the disk is very distinctly demarcated from the rays abactinally by massive plates which form a circumferential series—one plate at the base of each ray and four in each interradius; (ii.) the rays are particularly rigid, with the longitudinal mid-radial row of plates neither conspicuously large nor very prominent, and the papulæ of the rays are more or less restricted to two single or double rows, one on each side of the mid-radial row of plates [in *Z. Sigsbeei* the papular orifices seem to have been only doubtfully recognized (*tom. et loc. cit.*)]; (iii.) the three actinad rows of plates are much crushed together (? *Z. Sigsbeei*), and are always more densely covered with spinelets and more conspicuously armed than the plates of the abactinad rows, which last are often quite smooth and unarmed; (iv.) the anal aperture is very distinct.

This subgenus shows an interesting series of gradations between *Zoroaster*, Wyville Thomson, and *Cnemidaster*, Sladen. At the true *Zoroaster* extreme is *Zoroaster Gilesii*, with all the plates spinate and armed, with numerous pedicellariæ, and with a broad ambulacrum and four rows of tube-feet. Near the *Cnemidaster* extreme comes, as Mr. Sladen has already pointed out, *Z. Sigsbeei*, with the abactinad plates smooth and unarmed and only the actinad plates spinate, with few pedicellariæ, and with crowded tube-feet which only in the basal part of the ray are quadriserial. While between the two come (i.) *Z. squameus*, with the abactinad plates granular or quite smooth and their armature reduced to one deciduous spinelet, and (ii.) *Z. zea*, in which the abactinad plates are quite smooth and unarmed and the pedicellariæ reduced in size and number.

Family **Pterasteridæ.**

MARSIPASTER, Sladen.

45. *Marsipaster hirsutus*, Sladen.

Marsipaster hirsutus, Sladen, 'Challenger' Asteroidea, p. 487, pl. lxxviii. figs. 3 and 4, pl. lxxix. figs. 4 and 6; and in Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, p. 437.

Bay of Bengal, 1997 fathoms, *Globigerina*-ooze and pumice.

HYMENASTER, Wyville Thomson.

46. *Hymenaster nobilis*, Wyville Thomson.

Hymenaster nobilis, Wyville Thomson, Journ. Linn. Soc., Zool. vol. xiii. p. 73, fig. 11; Sladen, 'Challenger' Asteroidea, p. 495, pl. lxxxvii. figs. 1–3; and Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, p. 438.

Bay of Bengal, 1748 fathoms, *Globigerina*-ooze and pumice.

Family **Echinasteridæ.**

CRIBRELLA, Agassiz, Forbes.

47. *Cribrella præstans*, Sladen.

Cribrella præstans, Sladen, 'Challenger' Asteroidea, p. 545, pl. xcvi. fig. 7, pl. xcviii. figs. 7 and 8.

Four specimens from the Andaman Sea, 240 to 480 fathoms, on bottoms of green mud or of coral and *Globigerina*-ooze, only differing from the described type, which was dredged by the 'Challenger' in the Indian Ocean off the Crozet Islands, in having the disk relatively smaller. In one specimen the rays are most remarkably inflated in their basal fourth.

DICTYASTER, Alcock and Wood-Mason.

Rays 5.

Disk large, quite flat actinally, but slightly inflated abactinally, as are the broad rays; both disk and rays are invested throughout by a thick, smooth, coriaceous membrane, beneath which is a reticulum of plates.

Abactinal surface with coarse irregular plates, some or all of which bear coarse spinelets, and forming an irregular wide-meshed network, the meshes being occupied by large groups of papulæ.

Supero-marginal plates absent or inconspicuous; inferomarginals conspicuous and bearing one or more stout spines; the group of papulæ extend downwards as far as the inferomarginal plates.

Actinal interradial areas large, the smooth intermediate plates extending to the tip of the rays.

Adambulacral armature in the form of a double furrow-palisade.

Tube-feet in a double row, their tip ending in a sucker.

Madreporiform plate small, single. Anus subcentral. No pedicellariæ.

This genus appears to be nearest related to *Plectaster*; it is instituted for the reception of two Andaman forms, *Dictyaster xenophilus*, from deep water, and *Dictyaster Wood-Masoni*, a littoral form recently discovered in Prof. Wood-Mason's rich Andaman collection.

48. *Dictyaster xenophilus*, Alcock and Wood-Mason.
(Pl. V. figs. 8, 9.)

Dictyaster xenophilus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 438.

Rays 5. $R = 2{\cdot}5\ r$.

Disk large and, like the short broad rays, flat actinally, and often a little inflated abactinally; both disk and rays are everywhere invested in a thick leathery membrane which covers all the plates and their spines—abactinal, actinal, and adambulacral.

The narrow salient abactinal plates form a very wide-meshed network, the sunken meshes of which are occupied by large grouped masses of papulæ; all the plates carry coarse spines, either solitary or in rows of two or three.

The supero-marginal plates hardly differ from the ordinary abactinal plates in form and armature, but they constitute a fairly well-defined border to the rays.

The infero-marginals are separated from one another by an interval equal in length to the plates themselves; they are distinct laminæ, with their surface horizontal and with a sharp edge that projects laterally and bears a horizontal comb of three to five (usually three) coarse spines. The space between the two series of plates is occupied by papulæ in large isolated groups.

Adambulacral plates small, each with two, but near the actinostome often three, narrow ligulate spines along and almost within the furrow, and on the margin of the furrow with one much larger broadly ligulate spine, the truncated end of which is usually bilobed or trilobed; so that the narrow ambulacral groove is bounded on each side by a double palisade of ligulate spines, those of the outer series being about half as numerous but about twice as big as those of the inner series. Mouth-plates with a furrow-series of from four to six ligulate spines, increasing in size from the periphery to the centre, and actinally with two of the broadly ligulate spines, placed transversely.

Actinal interradial areas large; the plates, which are quite smooth and which are separated from one another by intervals equal in breadth to the plates themselves, extend nearly to the tip of the ray.

Madreporiform plate situated almost in an interbrachial arc, very finely and closely striated. Anus subcentral, surrounded by blunt spinelets.

Tube-feet in a double row, ending in a sucker.

Colour in the fresh state chestnut-brown.

A symbiotic Chætopod is often found on the actinal interradial areas, on which also it often lays its eggs.

Andaman Sea, 170 to 290 fathoms.

Family **Pedicellasteridæ.**

PEDICELLASTER, Sars.

49. *Pedicellaster atratus,* sp. n.

Rays 5. R = 11 *r*. R = about 100 millim. in the type specimen.

Disk extremely small, circular (button-like), abactinally delimited from the rays, with which it is flush, by a groove that passes across the base of each ray. Rays long, semi-cylindrical, constricted laterally, as well as somewhat depressed, near their junction with the disk.

Abactinal surface closely covered with partly imbricate cruciform plates which have no particular arrangement on the disk, but which on the rays stand in beautifully regular longitudinally and transversely parallel rows forming a quadrangular network of great symmetry. There are from twelve to fourteen longitudinal rows of plates on each ray between the adambulacrals. All the plates are embedded in a continuous membrane, and each plate carries at the decussation of its cross-pieces a stout erect spinelet. The membrane that closes over the quadrangular meshes between the plates is thickly studded with large pedicellariæ and is perforated by papulæ—one to three in each mesh.

Marginal plates quite undifferentiated.

There are no actinal plates, the actinal surface of the rays being almost entirely taken up by the broad ambulacral furrow.

The adambulacral plates are very small; each plate carries two long cylindrical truncated spines placed transversely, the outer spine being about twice the length and four times the thickness of the inner one, and usually having external to its base a large pedicellaria.

Although the ambulacral furrow is so broad the tube-feet are biserial.

Madreporiform plate small, radially striated, placed near the margin of the disk.

Colour uniform jet-black.

Andaman Sea, 240 to 220 fathoms, coral-sand and foraminiferal ooze; Bay of Bengal, 290 fathoms.

Family **Asteriidæ**.

ASTERIAS, Linn.

Subgen. STOLASTERIAS, Sladen.

50. *Asterias mazophorus*, Alcock and Wood-Mason.

Asterias mazophorus, Ann. & Mag. Nat. Hist., Dec. 1891, p. 436.

Rays 5. R=11 *r*. R=115 millim. in the type specimen.

Disk extremely small, circular (button-like), delimited abactinally from the rays, beneath the level of which it is sunk, by a deep groove passing across the base of every ray. Rays long, semicylindrical, much constricted laterally at the junction with the disk, and very deciduous.

Abactinal surface of the disk with a reticulum of plates embedded in tough membrane; each plate bears a large spine with its base sheathed in a globular fleshy mass closely covered with minute pedicellariæ; the meshes between the plates are perforated by papulæ in groups; numerous large pedicellariæ fill the interbrachial arcs and extend nearly to the actinostome.

Abactinal surface of the rays with five beautifully regular parallel rows of partly imbricating plates that may best be described as compositely cruciform—that it to say, each composite plate is made up of two cross series of tightly imbricating platelets. The outermost row of plates on each side forms a distinct supero-marginal series. All the plates are embedded in a tough membrane, and each plate of the mid-radial and supero-marginal rows, and in large specimens each plate of the other two rows also, bears at the decussation of its composite cross-pieces a large spine with its base ensheathed in a globular fleshy mass closely covered with pedicellariæ; other large pedicellariæ lie scattered over the plates. The quadrangular meshes between the plates are filled with papulæ in oval plots of from five to nine.

Marginal plates distinct; the supero-marginals, which otherwise resemble the abactinal plates, are distinguished by their mainly vertical direction, their long outer limbs forming a high vertical palisade along the sides of the ray; the broad intervals of the palisade are filled by papulæ in groups. The infero-marginals are simply oblong plates of small size lying at right angles to the long vertical limb of the supero-marginals, and having a considerable lateral horizontal bulge; each carries two strong horizontally-directed spines, one above and behind the other, the upper being the larger and exactly resembling the abactinal spines in form and in its ensheathing fleshy pedicellaria-covered base, the lower being quite simple.

Adambulacral plates very small, but extending up into the furrow; each carries a pair of spines placed transversely, and almost every alternate plate has inside the furrow a large pedicellaria.

The adambulacral plates are separated from the infero-marginals by a single row of small narrow plates distant almost their whole length apart, the long intervals between the plates being filled each with a large papula encircled by pedicellariæ. Mouth-plates ambulacral, each with two large spines.

Madreporiform body placed in the middle of a large basal (interradial) plate.

Anal aperture indistinct.

Tube-feet quadriserial, ending in a sucker.

Colour in the fresh state deep orange-yellow, with large chestnut-brown blotches.

Andaman Sea, 120 to 250 fathoms.

This is a very remarkable and interesting form, and has repeatedly led me on to difficult and uncertain ground. Its affinities, unlike those of some of its fellows of the Stolasterian alliance, appear to be more Stichasteroid and Zoroasteroid than Brisingoid.

Family **Brisingidæ.**

BRISINGA, Asbjornsen.

51. *Brisinga insularum*, Alcock and Wood-Mason.

Brisinga insularum, Ann. & Mag. Nat. Hist., Dec. 1891, p. 439.

Allied to *B. coronata*, Sars.

Rays 13.

Disk comparatively large (its diameter being 44 millim. in the type specimen), with vertical edge; rays not extremely deciduous (six of them still being firmly attached to the disk in the type specimen), but fragile, inflated and broadened in the basal (ovarian) region.

Abactinal surface of the disk invested by a tough opaque membrane, closely covered with coarse granules which form a base each for a tuft of minute spinelets.

Abactinal surface of the rays covered with a very delicate transparent membrane, which in the basal part of the rays is strengthened by from thirteen to seventeen sinuous, very salient, transverse ridges, armed with strongly spinate plates and covered with microscopic pedicellariæ. In the intervals between these ridges, as throughout the ray at regular close intervals, occur broad, slightly raised, felt-like, transverse bands of microscopic pedicellariæ.

The vertebra-like adambulacral plates have the following armature:—(i.) abactino-marginally, on a distinct but closely fused platelet, a needle-like spine ten to twelve times as long as the plate itself; (ii.) actino-marginally, a similar spine four to five times as long as the plate; (iii.) on the furrow-margin, one at each end of the plate, two spinelets as long as the plate; (iv.) deep within the furrow, on a distal epiphysis, a spinelet which stretches across the furrow to overlap with its fellow of the opposite plate and separate the pairs of tube-feet from one another. All these spines are hyaline, fluted, and invested in membranous sacs which are closely felted with pedicellariæ.

Actinostome large (25 millim. in diameter in the type specimen). Mouth-plates of moderate size, each plate distinctly formed of two fused adambulacrals, of which they bear the furrow and cross-furrow spinelets unchanged and the actino-marginal spines but little modified.

Madreporiform plate rather large, excavated centrally and divided by a deep groove into two halves, with fine radial striations, placed close to the margin of the disk.

Colour in the fresh state bright cinnabar-red.

Laccadive Sea, 1043 fathoms, green mud with foraminifera.

This species is characterized by its large disk with tough membrane and coarse tufts of spinelets, and by the great length and coarseness of its spinature.

52. *Brisinga andamanica*, Alcock and Wood-Mason.

Brisinga andamanica, Ann. & Mag. Nat. Hist., Dec. 1891, p. 439.

Rays 15. R=27 *r*.

Disk of moderate size (its diameter being 38 millim. in the type specimen), with vertical edge; rays very deciduous, but not fragile, long, slender, a little depressed, but not inflated in the ovarian region.

Abactinal surface of the disk much as in *B. insularum*, but the membrane is not so tough, and the tufts of spinelets and the tubercles on which they stand are not so coarse.

Abactinal surface of the rays covered with a very delicate transparent membrane, which in the proximal third of the ray is strengthened by about forty-five rather distant cross bands or half-bands of feebly developed spiny plates. In the intervals between these bands, as throughout the whole ray at regular intervals, occur very narrow felted bands of microscopic pedicellariæ.

The vertebra-like adambulacral plates have the following armature:—(i.) abactino-marginally a spine about six times as long as the plate; (ii.) actino-marginally a spine about four times as long as the plate; (iii.) a single furrow spinelet, placed at the adoral end, about equal in length to the plate; (iv.) deep within the furrow, on a distal epiphysis, a cross-furrow spine separating the pairs of tube-feet. All these spines are hyaline, fluted, and invested in sacs formed of membrane and felted microscopic pedicellariæ.

Actinostome large (25 millim. in diameter in the type specimen). Mouth-plates small, each plate formed of two adambulacrals, with the furrow and cross-furrow spinelets unchanged and the actinal spines not much modified; the most adoral actinal spine is enlarged and is often united with its fellow of the same pair in a common membranous investment.

Madreporiform plate rather small, excavated centrally, with fine radial striations, marginal in position.

Colour in the fresh state bright cinnabar-red.

Andaman Sea, 405 fathoms, green mud.

This species stands intermediate between *B. insularum* and the next species, *B. bengalensis*; it is well characterized by the extensive development along the rays of feeble calcareous plates.

53. *Brisinga bengalensis*, Alcock and Wood-Mason.

Brisinga bengalensis, Ann. & Mag. Nat. Hist., Dec. 1891, p. 439.

Rays 14. $R = 25\,r$.

Disk small (its diameter being 30 millim. in the type specimen), depressed centrally, with a strongly bevelled abactinal margin; rays very deciduous, but not otherwise very fragile, long, slender, hardly inflated in the ovarian region.

Abactinal surface of the disk much as in *B. andamanica*; abactinal surface of the rays covered with a very delicate transparent membrane, which in the basal ninth of the ray is strengthened by about twenty close cross bands or half-bands of spiny plates that are not very much more salient than the cross bands of felted pedicellariæ that occur throughout the ray.

The vertebra-like adambulacral plates have the following armature:—(i.) abactino-marginally a spine about five or six times as long as the plate; (ii.) actino-marginally a spine twice to two and a half times as long as the plate; (iii.) two furrow-spinelets not quite half as long as the plate; (iv.) deep within the furrow, on a distal epiphysis, a cross-furrow spine not quite as long as the plate, separating the tube-feet. All these are hyaline, fluted, and clothed with membrane and felted pedicellariæ.

Actinostome very large (21 millim. in diameter in the type specimen). Mouth-plates very small, each being distinctly formed of two fused adambulacrals, of which it carries the furrow-spinelets and cross-furrow spinelets unchanged; of the two actinal spines the adoral one is remarkable in being united with the corresponding spine of the fellow mouth-plate in a common membranous sac, so that each pair of mouth-plates appears to possess in this situation but one large ligulate spine between them.

Madreporiform plate large, salient, marginal, marked with fine but deep radial striations.

Colour in the fresh state bright cinnabar-red.

Bay of Bengal, 561 fathoms, grey mud.

This species is well characterized by the small disk with its bevelled edge; by the slenderness of the rays and by their short and very delicate spinature; and by the union in a common investing membrane of the two large actinal spines of each pair of mouth-plates.

54. *Brisinga Gunnii*, sp. n.

Rays 14–15.

Disk remarkably thin, its abactinal margin slightly bevelled; rays both very deciduous and very fragile, slender, not inflated in the ovarian region.

Disk covered abactinally with a very thin semitransparent membrane bearing small tufts of spinelets, of which the central in each tuft is sufficiently elongated to give *en masse* a downy appearance to the disk. In one of these specimens midway between the centre and the margin is a pair of large spines covered with microscopic pedicellariæ.

Rays covered with a membrane of extreme delicacy, which in the basal part of the ray is strengthened by from twenty to thirty very contorted calcareous ridges, these standing far out on each side like hoops, but becoming inconspicuous or quite obsolete abactinally. In the intervals between the ridges are narrow felted bands of pedicellariæ, which also occur in the region beyond the ridges, though, owing to excessive denudation, their exact disposition is not determinable.

The vertebra-like adambulacral plates have the following armature:—(i.) abactino-marginally a spine about six times as long as the plate; (ii.) actino-marginally a spine about two and a half times as long as the plate; (iii.) a single furrow-spinelet about as long as the plate; (iv.) deep within the furrow, on a distal epiphysis, a cross-furrow spine about as long as the plate, separating the pairs of tube-feet. All these are hyaline, fluted, and invested in a felt of membrane and microscopic pedicellariæ.

Actinostome large. Mouth-plates very small; each plate is made up of two adambulacrals so incompletely fused that in place of the usual groove there is a ligamentous symphysis between the two plates, and each bears the usual furrow and cross-furrow spinelets unchanged and the actinal spine not much changed—only diminished in size in the distal (aboral) plate.

Madreporiform plate marginal, small, deeply cross-fissured, radially striated. A membranous (epiproctal?) appendage is found on the disk excentrically.

Colours in the fresh state dull reddish ochre.

Off the Konkan Coast, 559 fathoms, green sand.

This species is well characterized by the strong contortion of the calcareous ridges at the base of the rays and their hoop-like lateral elevation; by the incomplete fusion and partially ligamentous union between the two adambulacral elements that make up a mouth-plate; and by the curious membranous epiproctal (?) appendage.

FREYELLA, Perrier.

55. *Freyella tuberculata*, Sladen.

Freyella tuberculata, Sladen, 'Challenger' Asteroidea, p. 638, pl. cxvii. figs. 1–3.

Bay of Bengal, 1840 fathoms, *Globigerina*-ooze.

56. *Freyella benthophila*, Sladen.

Freyella benthophila, Sladen, 'Challenger' Asteroidea, p. 641, pl. cxi. figs. 5–8; and in Wood-Mason and Alcock, "Indian Deep-sea Dredging," Ann. & Mag. Nat. Hist., Dec. 1891, p. 440.

Bay of Bengal, 1520 to 1997 fathoms, usually on *Globigerina*-ooze.

XVI.—*Report upon the Myriopoda of the 'Challenger' Expedition, with Remarks upon the Fauna of Bermuda.* By R. I. POCOCK, of the British Museum (Natural History).

[Plate IX.]

SINCE marine biological research was the main object of the cruise of the 'Challenger,' and the capture and preservation of terrestrial forms but a pastime, so to speak, of the zoologists on board, it is not difficult to understand why the species collected from time to time inland of the different ports that were touched at, were for the most part considered by those into whose hands they ultimately fell to be, if of interest at all, certainly not worthy of special reports. However justifiable this opinion was touching the majority of the land-forms of life, it can scarcely be said to hold good when we take the Myriopoda into consideration. Nor is this a surprising fact, seeing that many of the localities visited were isolated islands or localities rarely, if ever, explored by collectors; and consequently a large percentage of new forms was obtained—large, that is, considering that those who discovered them were without experience of the group, and merely picked up such specimens as presented themselves during the search after land-forms in general. But, apart from the new species, of which the value can only be appreciated by a specialist, the interest of the collection touching geographical distribution is in some respects very great. This is notably the case with regard to Bermuda.

Prior to the small report published by Mr. Bollman upon the Myriopoda obtained by Dr. Angelo Heilprin in Bermuda, I am not aware that any species of the group—authentically named or otherwise—have been recorded from this island.

Mr. Bollman mentioned five species in his paper; in the 'Challenger' collection there are in all seven, five of them being new to the locality and two of them doubtfully new to science.

The following is a complete list of the known species, with notes respecting their extra-Bermudan distribution:—

1. *Scutigera coleoptrata* (Linn.).

Common in South and West Europe, Madeira, and Azores, and probably introduced into Bermuda from the east. Not Antillean; but possibly Nearctic, if *Sc. forceps* is the same species.

2. *Lithobius provocator*, Pocock.

Certainly closely allied to, if indeed it be truly distinct from, the common European and N.-American *L. forficatus*. Not Antillean.

3. *Lithobius bermudensis*, Pocock.

Also a doubtful species. No doubt of European or Nearctic origin. Almost certainly not Antillean, the genus *Lithobius* being unknown in the West Indies.

4. *Lithobius lapidicola*, Meinert.

This species was identified with some hesitation by Bollman, to whom authentic examples of *L. lapidicola* were unknown. I see no reason, however, for doubting the correctness of the determination, seeing that *L. lapidicola* is a tolerably common European form and occurs also in Madeira.

5. *Scolopendra subspinipes*, Leach.

A widely distributed tropical species. Occurring commonly in the West Indies, whence it has doubtless made its way to Bermuda.

6. *Mecistocephalus Guildingii*, Newp.

Recorded by Bollman. A West-Indian species; occurs also in Demerara.

7. *Strongylosoma coarctatum* (Sauss.).

Like *Scolopendra subspinipes*, this is a widely distributed tropical species. Abundant in Guyana and the West Indies; occurs also in Europe, but only in conservatories or places to which tropical plants have been imported.

8. *Strongylosoma Guerinii*, Gervais.

Common in Teneriffe, Madeira, Algeria, &c., but not known upon the western side of the Atlantic.

9. *Iulus Moreleti*, Lucas.

Common in the Azores and Madeira, and closely allied to several species of the South-European fauna.

10. *Spirobolus monilicornis*, Porath.

Described from Bermuda under the name *Sp. Heilprini* by Bollman; but Bermudan specimens are not specifically distinguishable from others occurring in many of the West-Indian Islands and in Demerara, which are almost certainly *monilicornis* of Porath.

From the above list it will be seen that out of the ten known species four have been doubtless introduced from the West Indies, three are either of Palæarctic or Nearctic origin (*i. e.* nos. 1, 2, and 3), while the remaining three belong unquestionably to the Mediterranean fauna of the Palæarctic region.

Thus the western Palæarctic element is almost equal to the Antillean—a circumstance which is both interesting and surprising, seeing that the plants, land-mollusca, insects, and spiders appear to be almost wholly West-Indian or East-American.

Also of considerable interest was the small series of species obtained from Teneriffe, showing the distinctly Mediterranean character of the mainland fauna of this island.

Class **CHILOPODA**.

Fam. **Scutigeridæ.**

Scutigera coleoptrata (Linn.).

Loc. Bermuda.

Scutigera planiceps, sp. n.

Scutigera rugosa, Porath, "Myriopoda Africæ australis in Museo Regio Holmiensi asservata," Œfv. Vet.-Akad. Förhandlingar, 1871, no. 9, pp. 1138, 1139 (not *Scutigera rugosa*, Newport, Linn. Trans. xix. p. 353, 1845).

Loc. Simon's Bay (Cape Town). A single specimen.

Porath's description of this species is sufficiently accurate to leave no doubt as to the specific identity of his specimens with the one mentioned above. But since these specimens are certainly totally distinct from *rugosa* of Newport, the type of which is preserved in the British Museum, it is necessary that they receive a new name. It is proposed therefore to call them *planiceps*, in commemoration of perhaps their most marked characteristic, namely the flatness of the upper surface of the head.

Porath's specimens were evidently somewhat faded, for he merely describes them as being "supra nigrescens, subtus pallidior." In reality the general tint of the upper surface is a deep black-brown; but when more critically examined the tergites are seen to be adorned with a median black longitudinal band and to be black at the sides, the intermediate area being of a reddish-brown tint; the legs are a pale olivaceo-testaceous colour and the tarsi are ochraceous. The stomata are small and the stoma-saddles very low.

Sc. rugosa of Newport, from East Africa, which Porath mistook for this species, is very different. It is a very beautiful form, the tergites being a deep black, this sombre colouring being relieved by an orange-yellow median dorsal band which runs without interruption from the fore part of the head to the hinder end of the body; moreover the lower surface and legs are also orange-yellow, these last being beautifully ringed with black. The head, too, is deeply excavated, the stoma-saddles are elevated, and the generative forceps has its distal segment smooth and not serrate internally.

Sc. planiceps seems to have a wide distribution in South Africa. Porath has recorded it from the Cape of Good Hope and Caffraria, and the British Museum has a single example which was collected by Gueinzius at Port Natal.

Fam. **Lithobiidæ.**

Henicops maculatus, Newport.

Henicops maculata, Newport, Trans. Linn. Soc., Zool. xix. p. 372, pl. xxxiii. fig. 27, and pl. xl. fig. 3; id. Catalogue Myr. Brit. Mus. p. 22.

Henicops impressus, Hutton, Ann. & Mag. Nat. Hist. (4) xx. pp. 114, 115 (1877); id. Tr. N. Z. Inst. x. p. 288 (1877).

Henicops maculata, Haase, "Die Indisch-Austral. Chilopoden," Abhandlungen Dresden Museum, 1887, no. 5, p. 36; Pocock, Ann. & Mag. Nat. Hist. (6) viii. p. 154 (1891).

Loc. Wellington (New Zealand).

Henicops insignis, Pocock.

Henicops insignis, Pocock, Ann. & Mag. Nat. Hist. (6) viii. p. 154.

Loc. Juan Fernandez.

Henicops tristani, sp. n.

Colour fusco-ochraceous; antennæ entirely flavous, legs flavous distally.

Head convex from side to side, the anterior median portion angularly notched. *Antennæ* short, composed of 23–24 segments.

Coxæ of the maxillipeds produced forwards mesially and armed with 2+2 sharp teeth. *Tergites* smooth, with all their posterior angles rounded and their hinder borders not emarginate. Coxal pores rounded, 3, 3, 3, 2. Generative forceps of the female with two short spurs rising just below the apex of the internal posterior angle of the segment; claw simple.

Length up to 10 millim.

Loc. Tristan Island (Tristan d'Acunha).

This species is closely related to *H. africanus* of Porath, from South Africa. It appears to differ, however, in having fewer antennal segments. In Porath's species, judging from a number of examples sent to the British Museum from Cape Town and Port Elizabeth, the usual number of segments to these appendages is 30, but it varies from 26 to 35, whereas in *H. tristani* the number is 23 to 24 in four specimens.

Lithobius pilicornis, Newp.

Lithobius pilicornis, Newport, Ann. & Mag. Nat. Hist. xiii. p. 96. no. 5 (1844); id. Tr. Linn. Soc. xix. p. 369; Pocock, Ann. & Mag. Nat. Hist. (6) vii. p. 372.
Lithobius Sloanei, Newport, Ann. & Mag. Nat. Hist. xiii. p. 96. no. 6 (1844); id. Tr. Linn. Soc. xix. p. 369.
Lithobius longipes, von Porath, Œfv. Vet.-Akad. Förh. xxvii. p. 816 (1870); Meinert, Nat. Tidskr. (3) viii. p. 323.
Lithobius galatheæ, Meinert, Vid. Medd. Foren. 1884–86, p. 109.

Loc. Teneriffe (Canary Islands).

Lithobius provocator, Pocock.

Lithobius provocator, Pocock, Ann. & Mag. Nat. Hist. (6) viii. p. 152.

Loc. Bermuda.

Lithobius bermudensis, sp. n. (?).

Colour uniform fusco-ochraceous; legs flavous, head ochraceous.

Head smooth, cordate; *eyes* composed of about 10 ocelli, 1 + 4, 3, 2. *Antennæ* broken off.

Coxæ of the maxillipedes armed with 2 + 2 strong acute teeth.

Tergites at the posterior end of the body lightly rugose; the posterior angles of 9, 11, and 13 strongly dentate.

Coxal pores rounded, in a single series, 4, 5, 5, 4.

Anal legs long but moderately thick, armed beneath with 1, 3, 2, 1 spurs; claw spurred.

Generative forceps of the female with two longish, subequal, subparallel spurs and trilobate claw.

Length 14·5 millim., with anal leg 19 millim.

Loc. Bermuda.

I am rather doubtful as to the distinctness of this species, partly owing to the imperfection of the antennæ of the type specimen and partly to my ignorance of the North-American species of the genus. I cannot, however, match it with any European species with which I am acquainted.

Fam. **Scolopendridæ.**

Scolopendra morsitans (Linn.).

Loc. St. Iago (Cape Verde); Zebu (Philippine Islands).

Scolopendra mutilans, L. Koch.

Scolopendra mutilans, L. Koch, Verh. z.-b. Ges. Wien, 1878, p. 791; Haase, *op. cit.* pp. 47, 48.

Loc. Yokohama.

Scolopendra chilensis, Gervais.

Scolopendra chilensis, Gervais, Ins. Apt. iv. p. 285 (1847); id. in Gay's Hist. de Chile, Zool. iv. p. 67, fig. 7 (1849); Meinert, Proc. Am. Phil. Soc. 1886, pp. 199, 200.

Loc. Valparaiso.

Pithopus calcaratus, Pocock.

Pithopus calcaratus, Pocock, Ann. & Mag. Nat. Hist. (6) vii. pp. 224, 225.

Loc. Bahia.

Cormocephalus violaceus (Fabr.).

Scolopendra violacea, Fabr. Suppl. Ent. Syst. p. 289; Guérin-Méneville, Icon. Règne Anim. ii., Ins. pl. i. fig. 8.
Cormocephalus calcaratus, Porath, Œfv. Vet.-Akad. Förhandl. 1871, no. 9, pp. 1159, 1160.

Loc. Simon's Bay (Cape of Good Hope).

There can be very little doubt, I think, as to the correctness of the above synonymy. Fabricius's description and Guérin's figure are accurate enough to preclude the likelihood of error in the identification of the species. Newport never saw an example of it; he consequently retained the name *violacea* under the genus *Scolopendra*, an error which gave rise to two others. For, in the first place, Newport himself described a New Zealand species of *Cormocephalus* as *violaceus*, and Porath, following Newport's opinion respecting the generic position of Fabricius's *violaceus*, recharacterized it as a *Cormocephalus* which he called *calcaratus*. *C. calcaratus* is consequently a synonym of *C. violaceus* (Fabr.), and the New Zealand *violaceus* of Newport, which is different from the African, must be renamed. I propose to call it *purpureus*.

Cormocephalus rubriceps, Newp.

Cormocephalus rubriceps, Newport, Tr. Linn. Soc. xix. p. 419; Haase, *op. cit.* p. 57.

Loc. Maua Island (New Zealand).

On the parchment label accompanying this species is written "Centipede now confined to the island of Maua."

Cormocephalus Huttoni, sp. n.

Cormocephalus violaceus, Hutton, Tr. N. Z. Inst. x. p. 289, 1877 (not *violaceus* of Newport).

Colour (in alcohol and certainly faded) olivaceous or ochraceous, often with metallic lustre, the head, first segment, anal segment, legs, and antennæ pale ochraceous.

Head usually a trifle longer than wide, distinctly punctured. *Antennæ* composed of 17 segments, whereof about the basal 7 or 8 are naked.

Prosternal plates of the coxæ tolerably long, in contact, each furnished with 4 acute teeth. *Tergites* punctured, from the second bisulcate, from the eighth marginate.

Sternites bisulcate, not otherwise impressed.

Anal somite.—Tergite not mesially sulcate, nearly parallel-sided, a little wider than the head, but narrower than the first and twentieth; *pleuræ* densely porous, the process long, slender, tipped with two spines, another minute spine on the posterior border of the pleuræ; *sternite* posteriorly narrowed.

Legs short and moderately robust, the femur incrassate posteriorly, a little more than twice as long as wide; the process moderately large, tipped with two spines, the inner surface usually armed with 6 small spines, 2 above, 2 in the middle, and 2 below, the lower surface only very shallowly excavated, the external carina being low and armed with 2, 2 spines in two series; claw without basal spurs.

Rest of the legs with unspined tarsi.

Length up to 70 millim., of antenna 10, of anal leg 11; width of anal tergite 4·2, of head 4+.

Loc. New Zealand.

These specimens are specifically identical with one of Prof. Hutton's examples of his *violaceus*, Newp., which the British Museum obtained from the Otago University Museum. This specimen is ticketed Wellington; so in all probability the 'Challenger' examples came from the same locality. The Museum also has an example from Waikouaito.

The species differs from *C. purpureus*, Pocock (=*violaceus*, Newp., *cf. suprà*), in having no spurs at the base of the claw on the anal leg and in having 4 spines in two series on the lower surface of the femur of the anal leg. In *purpureus* there is a single series of 3 spines in this position and the claw of the anal leg is spurred; the anal pleuræ, moreover, have a shorter and more angular process. *C. Huttoni* is most nearly allied to *C. fœcundus* of Newport, from Van Diemen's Land and South-east Australia. It differs, however, at least in having no median sulcus on the anal tergite.

Heterostoma rubripes, Brandt.

Heterostoma rubripes, Brandt, Recueil &c. p. 65; Haase, *op. cit.* p. 89, pl. v. fig. 93.

Loc. Cape York (N. Australia).

Heterostoma viridipes, Pocock.

Heterostoma viridipes, Pocock, Ann. & Mag. Nat. Hist. (6) vii. pp. 56, 57, pl. iv. fig. 2.

Loc. Ternate.

? *Cryptops hortensis*, Leach.

Loc. Teneriffe.

The identification of this species is doubtful on account of the absence of the anal legs.

Cryptops australis, Newport.

Cryptops australis, Newport, Tr. Linn. Soc. xix. pp. 293 and 408.

Loc. Wellington (New Zealand).

Geophilus challengeri, Pocock.

Geophilus challengeri, Pocock, Ann. & Mag. Nat. Hist. (6) viii. pp. 217, 218, pl. xii. fig. 3.

Loc. St. Iago (Cape Verde).

Fam. **Geophilidæ.**

Himantarium dimidiatum, Meinert.

Himantarium dimidiatum, Meinert, Nat. Tidskr. Kröyer, (3) vii. pp. 30, 31 (1870–71).

Loc. Teneriffe (Canary Islands).

Recorded originally from Seville and Madeira.

Geophilus antipodum, Pocock.

Geophilus antipodum, Pocock, *loc. cit.* pp. 222, 223, pl. xii. fig. 8.

Loc. Wellington (New Zealand).

Geophilus provocator, Pocock.

Geophilus provocator, Pocock, *loc. cit.* p. 225, pl. xii. fig. 10.

Loc. Wellington (New Zealand).

Class **DIPLOPODA**.

Order ONISCOMORPHA.

Fam. **Glomeridæ.**

Sphœrotherium angulatum, Butler.

Sphærotherium angulatum, Butler, Tr. Ent. Soc. 1878, p. 299, ♀.
Sphærotherium walesianum, Karsch, Arch. Nat. 1881, p. 31, pl. ii. fig. 1, ♂.

Loc. Queensland.

Butler's specimens were from Rockhampton, the type of *walesianum* from Sydney.

Order HELMINTHOMORPHA.

Fam. **Polydesmidæ.**

Strongylosoma gracile (C. Koch).

Fontaria gracilis, C. Koch, Syst. d. Myr. p. 142 (1847); id. Die Myr. ii. p. 51, fig. 173.
Paradesmus gracilis, Latzel, Tömösvary, &c.

Loc. Sandwich Islands (Hilo and Honolulu); Cape of Good Hope.

Strongylosoma coarctatum, Sauss.

Paradesmus coarctatus, Sauss. Mém. Mex. Myr. p. 39, fig. 18 (from the Mém. Soc. Phys. Genève for 1860).
? *Paradesmus coarctatus*, Humb. & Sauss. Verh. z.-b. Wien, xix. pp. 670, 671 (1869).
Paradesmus vicarius, Karsch, Arch. f. Nat. 1881, p. 38, pl. iii. fig. 8.
Strongylosoma Poeyi, Bollman, Ent. Amer. iii. p. 81.

Loc. Bermuda; Mactan and Zebu (Philippines).

Very common in the West Indies and in Guyana, Burma.

Strongylosoma Guérinii, Gervais.
(Pl. IX. fig. 2.)

Polydesmus Guérinii, P. Gervais, Ann. Soc. Ent. Fr. v. p. 686 (1836); id. Ins. Apt. iv. p. 116, pl. xlv. fig. 3 (1847); Humbert and Saussure, Verh. z.-b. Ges. Wien, xix. pp. 685, 686 (1869).
Polydesmus cylindraceus, P. Gervais, Ins. Apt. iv. p. 117, pl. xlv. fig. 3 *c*.

Loc. Teneriffe; Bermuda.

This species has hitherto been recorded from Barbary, Marocco, Algeria, and Madeira. The British Museum has many from the two latter localities.

Strongylosoma Gervaisii (Lucas).
(Pl. IX. figs. 1, 1*a*.)

Polydesmus Gervaisii, Lucas, Hist. Nat. Anim. Articul. Apt. p. 525 (1840); Gervais, Ins. Apt. iv. p. 118.

Strongylosoma trilineatum, Newport, Ann. Nat. Hist. xiii. p. 266 (1844).

Strongylosoma Petersii, L. Koch, Verh. z.-b. Ges. Wien, 1865, p. 882; Karsch, Arch. Nat. 1881, p. 44.

Loc. Paramatta.

Stenonia tuberosa, sp. n.
(Pl. IX. figs. 3–3*b*.)

♀. *Colour* deep *café-au-lait*, with the antennæ, legs, and margins of the keels brunneo-fulvous.

Antennæ short.

Collum convex from side to side, the anterior border evenly rounded from the apex of one keel to that of the other, the keel triangular, depressed, its posterior border oblique and not continuing the curve of the hinder border of the tergite; a transverse groove sometimes running along the anterior border, closely covered with rounded tubercles, those along the two borders larger than the others. The rest of the segments granular or tubercular like the first, all of them marked with three distinct rows of larger tubercles; the keels slightly depressed, rising a little above the middle of the side, not large, squared, the anterior border smooth, with a distinct basal shoulder, the posterior border smooth, the lateral border furnished with from 4 to 6 smooth rounded tubercles (that is including the anterior and posterior angle). *Pores* close to the lateral margin, separated from it by a space about equal to their own diameter.

Anal tergite evenly rounded, at most lobulate. Lateral surface of the segments closely granular and rugose.

Sterna not spined.

♂. A little narrower and flatter than the female, the keels being a trifle larger. The copulatory feet terminating distally in two processes, the distal simple, long, slender, and lightly curved, the proximal itself dividing into two—an upper strongly curved and dilated at its distal end, an under simple and pointed.

Length, ♂ 40 millim., width 6·5; ♀, length 44, width 7·3.

Loc. Ki Dulau (Ki Islands).

Fam. **Iulidæ.**

Iulus Moreleti, Lucas.

Iulus Moreleti, Lucas, in Arthur Morelet's 'Notice sur l'Histoire Naturelle des Azores,' Paris, 1860, p. 96; Porath, Bih. Sv. Vet.-Akad. Handl. no. 7, p. 821 (1870).

Loc. Bermuda.

Described originally from the Azores by Lucas and subsequently recorded by Bollman from Bermuda. The British Museum has examples of what is apparently the same species from Madeira.

Iulus canariensis, sp. n.

Colour black, in spirit greyish blue banded with black; legs pale.

Body very long and slender.

Head smooth, with a frontal sulcus and a transverse stria between the eyes; without apparent frontal setæ. *Eyes* large, with ocelli distinctly defined, arranged in six transverse rows. *Antennæ* absent.

Collum smooth above, triangular laterally, striate just above the angle. The rest of the segments with complete transverse sulcus and a median dorsal longitudinal sulcus, all of them, including the second, longitudinally striated behind the sulcus, the striæ fine, complete, and very close-set, the area in front of the sulcus smooth. *Pores* large, situated about one third of the distance behind the sulcus, which is at this spot lightly sinuate forwards, the space between the sulcus and the pore not striate.

Anal tergite not surpassing the valves; valves convex, not compressed or marginate.

Anterior legs of the male hook-like.

Number of segments about 60.

Length up to about 26 millim.

Loc. Teneriffe.

In its black colouring, slender build, position of pores, &c. this species at first sight seems to fall into the *Ophiulus* section of Berlese; but the absence of a spine on the terminal segment serves at once to distinguish it.

Iulus tristani, sp. n.
(Pl. IX. figs. 5, 5 *a*.)

Colour fuscous or flavous and fusco-annulate; head yellower, with fuscous fascia between the eyes; legs and antennæ flavous; anal somite fuscous.

Head smooth, without frontal setæ. *Eyes* obscurely manifested, represented by a patch of black pigment. *Antennæ* short, scarcely surpassing the collum.

Collum laterally angular and marked with a few striæ. The first five segments smooth above, striate at the sides; the rest striate above and at the sides, the striæ not close-set and not reaching the hinder border of the segments. The sulcus complete and deep, crenulate, the area in front of it smooth. The *pores* conspicuous, situated just behind the sulcus, and, except at the hinder end of the body, touching it, the sulcus being posteriorly angled to meet the pore.

Anal tergite covering the summit of the valves, sometimes just surpassing them; valves convex, not compressed, and scarcely hairy; *sternite* triangular.

Legs short.

♂. Smaller and thinner than female. The first pair of legs small and hook-like; the second pair without coxal processes; the second segment of the mandible produced backwards into a large rounded prominence.

Number of segments up to 44.

Length up to 15 millim.

Loc. Inaccessible Island and Tristan Island (Tristan d'Acunha).

Iulus solitarius, sp. n.
(Pl. IX. fig. 4.)

Colour very like that of *I. pusillus* of Leach; two longitudinal flavous dorsal bands, the median dorsal line and the sides of the body black, the lower surface and legs flavous; antennæ and space between the eyes fuscous.

Head lightly punctulate, without distinct frontal pores. *Eyes* well developed, subcircular, composed of at least five distinct rows of well-defined ocelli. *Antennæ* a little longer than in the preceding species.

The *collum* laterally acutely triangular, margined, its anterior border lightly sinuate; the first three or four segments smooth above, striate at the sides, the rest striate above and below, the striæ deep but not close-set and not reaching the hinder border of the segments. The sulcus deep, the area behind it raised, that in front of it smooth. *Pores* scarcely at all conspicuous, situated just behind the sulcus but touching it, the sulcus lightly anteriorly angled.

Anal tergite surpassing the valves a little, the process short and down-curled; valves convex, not compressed, and smooth; *sternite* acutely triangular and very long.

Legs longer than in *I. tristani.*

♂. Smaller and thinner than female. The first pair of legs small and hook-like, the second pair with simple coxæ; mandible angularly produced.

Number of segments 33–34.

Length up to about 10 millim.

Loc. Tristan d'Acunha (Inaccessible Island and Tristan Island).

Iulomorpha Porathi, sp. n.

Colour black, with two flavous or testaceous spots on the dorsal area of the segments, constituting two parallel flavous bands; anal tergite black and polished, anal valves, legs, and antennæ testaceous; head fusco-ferruginous, with a deeper fascia between the eyes.

Head smooth, with weak frontal sulcus and a fine stria between the eyes; labral pores 4+4. *Eyes* widely separated, small and triangular, composed of about three transverse rows of ocelli. *Antennæ* longish, reaching past the second segment.

Collum laterally elongate, triangular, with a marginal sulcus and two longitudinal sulci, smooth above. The rest of the segments without trace of a transverse sulcus, merely marked by a shallow transverse groove, the area behind this groove smooth above, inferiorly finely ridged longitudinally, the covered area of the anterior portion closely and finely transversely striate in front. The *pores* large, above the middle of the side at some little distance behind the transverse groove. *Sterna* finely striolate.

Anal tergite covering but not surpassing the valves; valves convex, not compressed and not marginate.

Sternum obtusely rounded.

Legs sparsely setose beneath.

Number of segments 47.

Length about 36 millim., width 2·5.

Loc. Malamaui (Philippine Islands). Two female examples.

I take great pleasure in dedicating this striking species, the second known of the genus, to Dr. C. O. von Porath, who was almost the first zoologist to describe exotic Myriopoda with accuracy.

This new form *I. Porathi* agrees tolerably closely with the South-African *I. Kinbergi* in most of its structural features. It may at once be recognized, however, by its marked colouring and smaller number of segments.

The second example, measuring only about 12 millim., with

35 segments, and apparently the young of the large one described, has the yellow dorsal spots much smaller and visible just above the pore, the collum almost entirely flavous, and a faint though distinct transverse stria on the segments.

Spirostreptus chilensis, Gervais.

Iulus chilensis, Gervais, Ins. Apt. iv. p. 193; id. in Gay's Hist. de Chile, Zool. iv. p. 61, fig. 3 (1849).
Spirostreptus chilensis, Porath, Bih. Sv. Vet.-Akad. Handl. iv. no. 7, p. 41.

Loc. Valparaiso.

Spirostreptus erythropareius, Brandt.

Spirostreptus erythropareius, Brandt, Bull. Ac. Sci. St.-Pétersb. viii. nos. 175 and 176, p. 111 (1841); Gervais, Ins. Apt. iv. p. 155; Porath, Œfv. Vet.-Akad. Förh. 1872, no. 5, p. 36.
Spirostreptus rubripes, Newport, Ann. & Mag. Nat. Hist. xiii. p. 270 (1844).

Loc. Cape of Good Hope.

Spirostreptus Moseleyi, sp. n.
(Pl. IX. figs. 6, 6*a*.)

Colour brunneo-fuscous; legs and antennæ ferruginous.

Body moderately robust, not attenuated at its posterior end, narrowed at about the fourth segment.

Head sculptured below, nearly smooth and faintly sulcate above. *Eyes* acutely angled internally, separated by a space that is greater than a diameter. *Antennæ* about as long as the head.

First tergite narrowed laterally, both the anterior and posterior border lightly emarginate, the anterior angle roundedly rectangular, the posterior acutely rectangular; a strong marginal sulcus and two abbreviated sulci. The rest of the somites with conspicuous and complete transverse sulcus, the anterior covered area finely transversely striolate, the median and posterior portions finely sculptured, the sculpturing consisting of fine close-set longitudinal striolæ; the posterior portion longitudinally striate about a third of the way up to the pore; pores behind the sulcus. *Ventral grooves* long, but not quite as long as the two basal segments of the leg.

Anal somite large, punctulate; *tergite* posteriorly angled, lightly constricted, the process not projecting beyond the apex of the valves; *valves* convex, prominent, with their margins strongly compressed; *sternite* triangular, without trace of suture.

Legs short, mostly with a single seta on the lower surface of each segment.

Number of segments 70.

Length about 115 millim.

A single female example from Malamaui (Philippines).

This species differs from all the Indo- and Austro-Malayan forms that are characterized by long ventral grooves in that there is no caudal process overlapping the valves.

ACANTHIULUS, Gervais.

Acanthiulus, Gervais, Ann. Sci. Nat. (3) 1, p. 70; Ins. Apt. iv. p. 173.

The species of *Acanthiulus* can scarcely be regarded as more than extremely well-marked forms of *Spirobolus*. The constitution of the mouth-parts and the number and disposition of the legs of the anterior segments are the same in the two groups. In fact the only character by which *Acanthiulus* is to be distinguished is the presence of a transverse row of (8) spiniform tubercles on most of the segments. Nevertheless the collum is undoubtedly much longer than is usually the case in *Spirobolus*. This last character no doubt misled Gervais into stating that his species belonged to the genus *Spirostreptus* of Brandt, and probably this statement, coupled with the presence of the spines on the segments, will account for Latzel's erroneous surmise that *Acanthiulus* and *Trachyiulus* were synonyms.

Acanthiulus Murrayi, sp. n. (Pl. IX. figs. 7–7 *b*.)

Colour black or olivaceous, with a series of red spots on each side marking the pore; legs and antennæ olivaceous, with the distal ends of the segments flavo-annulate.

Face entirely smooth, the frontal sulcus mesially interrupted; labral border somewhat deeply excised; pores 2 + 2. *Eyes* well developed, subcircular, separated by a space equal to about twice a diameter. *Antennæ* long and slender, much longer than the face.

Collum smooth above, projecting laterally below the level of the second segment, the anterior border of the lateral portion widely emarginate and defined by a deep sulcus, which curves round the inferior border, the posterior border deeply and abruptly emarginate; the inferior surface of the second segment flat, with carinate anterior border, the posterior margin of this segment longitudinally grooved below, irregularly wrinkled above, with a squamiform tubercle in the middle of the lateral surface; the third, fourth, and fifth segments sculptured like the second, but more coarsely, the squamiform tubercles that are so characteristic of the succeeding segments becoming gradually more and more manifested. The rest of the segments with their posterior portions longitudinally grooved or wrinkled from base to summit and furnished with 8 equidistant, spiniform, squamiform tubercles, forming 8 longitudinal rows of spines: the lowest of these series is situated just below the middle of the side and begin on the seventh segment; the second series, beginning at the sixth segment, is situated just below the level of the pores, the spines are larger than those of the lowest series; the upper series on each side is composed of flatter tubercles, which, nearly obsolete on the anterior segments, become spiniform only at the hinder end of the body; in the middle line of the dorsum there is a faint indication of a similar series of tubercles. The tubercular area of the segments is lightly elevated and separated from the anterior area, which is rugose and finely transversely striolate in front, by a shallow depression representing the transverse sulcus. *Pores* conspicuous, situated in front of the sulcus and just above and in front of the large tubercle of the median lateral series; the anterior pore far below (1·5 millim.) the level of the rest, and situated immediately in front of the tubercle, which is itself lower than those on the rest of the segments. *Sterna* finely striolate transversely.

Anal somite large; *tergite* without spines but rugulose, the posterior angle elongate but not surpassing the summit of the valves; *valves* with strongly compressed margins, finely rugulose in front, coarsely rugose and punctured behind; *sternite* large and angular.

Legs longish and slender, with a single seta below each segment, except the tarsus, which has about three; the anterior legs, at least in female, shorter, thicker, and more setose beneath.

Number of segments 50.

Length 111 millim., width 11.

Loc. Wokan Dobbo (Aru Islands).

Acanthiulus Blainvillei, Le Guillou*, from New Guinea, the only other known species of the genus, differs from this new form, if we may trust Gervais's figure, in having the antennæ shorter than the face, the antero-lateral border of the collum less widely emarginate, and the posterior angle more strongly produced. Moreover the spiniform tubercles are well developed on the anterior segments.

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* Bull. Soc. Phil. Paris, 1841, p. 86; Gervais, Ins. Apt. iv. p. 173, pl. xliv. fig. 8.

I have great pleasure in dedicating this interesting new species to Dr. John Murray.

Spirobolus monilicornis, Porath.

Spirobolus monilicornis, Porath, Bih. Sv. Vet.-Akad Handl. iv. no. 7, p. 31 (1876).
Spirobolus Heilprini, Bollman, Proc. Ac. Philad. 1889, p. 127.
? *Spirobolus virescens*, Daday, Term. füzetek, xiv. p. 140, pl. vii. figs. 8–10.

Loc. Bermuda.

This species occurs commonly in many of the West-Indian Islands and also abundantly in Demerara. Dr. Porath's examples were ticketed Brazil. *S. Heilprini* was described from Bermuda, and *virescens*, which appears to be the same species, from Trinidad.

Spirobolus digrammus, sp. n.
(Pl. IX. figs. 9–9 *b*.)

? *Spirobolus tessellatus*, Porath, *op. cit.* p. 21 (in part only, *i. e.* the example from the Cape).

Colour.—Head fuscous above, flavous below the eyes; legs and antennæ bright red, concolorous; first tergite black, with its anterior border blood-red, the rest of the segments blood-red in their lower half, black in the upper, with two complete parallel blood-red bands running from the posterior margin of the first tergite to the anal somite; anal valves red.

Head punctulate, with a median sulcus above and below, with four labral pores. *Eyes* separated by a distance about equal to twice a diameter, subcircular, each composed of about 44 ocelli.

First tergite punctulate or striolate, the lateral portion narrowed to an angle, with only an anterior marginal sulcus. The rest of the tergites punctulate and striolate throughout, longitudinally striate laterally behind the transverse sulcus, but the striæ not extending as high as the pore; the transverse sulcus nearly obsolete above. The *pores* large, above the middle of the side, the anterior the lowest, close to each is a posterior longitudinal stria; *scobina* present in most of the somites, but small.

Anal somite punctulate, the *tergite* with a somewhat sharp but short median posterior angle; *valves* convex, with margins neither sulcate nor compressed; *sternite* posteriorly angled.

Legs short, with a single seta above the claw and each segment furnished distally beneath with one seta; the male with the distal segment padded beneath.

Copulatory feet of the male as in fig. 9 *b*.

Number of somites 45–46.

Length about 40 millim.

Loc. Cape Town (Simon's Bay).

So far as colouring is concerned this species approaches *Sp. formosus* of Porath; but I infer from the description of this last that the red dorsal bands are not continuous. Moreover, *formosus* is said to be "læve," and the anal valves are compressed. In colouring again this species very much resembles *Sp. litoralis*; but in *litoralis* the whole head is red and the dorsal spots are not continuous from segment to segment. Porath mentions one specimen of *litoralis* (his *tessellatus*) as coming from Cape Town and having a fuscous band between the eyes. This example, I strongly suspect, is in reality to be referred to this species.

Spirobolus cupulifer, Voges.

Spirobolus cupulifer, Voges, Zeitschr. wiss. Zool. xxxi. p. 188.

Loc. Zamboanga and Zebu (Philippine Islands).

Recorded originally from Bohol.

Spirobolus challengeri, sp. n.

(Pl. IX. figs. 10–10 *c*.)

Colour olivaceo-fuscous, most of the segments adorned posteriorly and laterally with an inferiorly narrowed orange-yellow stripe, which runs along the hinder margin, beginning on a level with the pore and extending halfway towards the legs; legs and antennæ narrowly testaceo-annulate.

Head convex, shining, smooth or only very finely striolate, with two pores on each side of the labrum, with a longitudinal mesially nearly obsolete sulcus. *Eyes* subcircular, consisting of about seven transverse rows of ocelli, separated by a space equal to twice a diameter. *Antennæ* short, shorter than the head, segments subequal.

First tergite smooth, its anterior edge lightly emarginate on a level with the eye, the inferior angle wide, subacute, with a faint anterior sulcus. The rest of the somites finely striate laterally, the striæ falling far short of the pore, the posterior portion smooth above, the anterior portion only very finely striolate, the transverse sulcus visible only at the sides. The *pores* conspicuous, situated just behind the position of the sulcus, above the middle of the side. *Scobina* large, crescentic, extending from about the tenth to about the fortieth segment, but very small towards the end of the body.

Anal tergite smooth above and scarcely constricted, produced behind into a short caudal process which scarcely covers the tops of the valves; *valves* with their margins widely compressed; *sternite* large, rounded, obtuse-angled.

Legs with a single seta on the lower surface of each segment; none of the segments padded; the coxæ of the third, fourth, and fifth legs produced, and the inferior surface of these legs, as well as of the sixth and seventh, inflated beneath.

Copulatory feet with the anterior median lamina wide, half-moon-like above, bearing a median, downwardly directed, slender, pointed linguiform process, which projects far below the level of the anterior lateral lamina and also below that of the posterior lateral lamina.

Number of somites 46–48.

Length 83 millim.

Two male examples from Ki Dulau, one of the islands of the Ki or Kei group, in the Banda Sea, off the coast of New Guinea.

Spirobolus flavo-collaris, sp. n.
(Pl. IX. fig. 11, 11 *a*).

Closely allied to the preceding species.

Colour dark greenish black, with the legs, antennæ, labial border, and posterior border of the somites ochraceous; the collum entirely bordered with ochraceous, the anterior stripe wider than the posterior. The somites smooth, striate below, the sulcus very feeble, obsolete above; *scobina* large and extending to about the thirty-sixth segment.

The *anal somite* small, the hinder end of the body being narrowed from above downwards and from side to side; the posterior border of the tergite produced into an angle of about 90°; the valves prominent, very lightly compressed behind.

Number of somites 52.

Length about 50 millim., width 6·5.

A single example from Wokan Dobbo, Aru Island.

Spirobolus dorsalis (Le Guillou).
(Pl. IX. fig. 8.)

Iulus dorsalis, Le Guillou, Bull. Soc. Phil. Paris, 1841, p. 86; Gervais, Ins. Apt. iv. p. 175.

Colour.—The posterior borders of the segments fusco-ferruginous, the anterior part testaceous; a large anteriorly narrowed black spot in the middle line of the back, the series of spots constituting a continuous longitudinal dorsal band from the collum to the end of the anal tergite; a fuscous patch marking the pore; the collum widely flavous along its anterior border and lateral angles; upper half of head fuscous, lower flavous; antennæ distally fuscous; legs flavous.

Face smooth, indistinctly sulcate. *Pores* 2 + 2. *Eyes* large, separated by a space that is about equal to a diameter. *Antennæ* slender and longish, extending to the end of the second segment.

Collum laterally acutely angled, the posterior border vertical, the anterior obliquely cut away and lightly emarginate, the apex not reaching the inferior border of the second. The rest of the segments lightly punctulate and striolate above, the longitudinal striæ of the lateral portion extending almost up to the pore and passing on to the area in front of the transverse sulcus; this sulcus represented dorsally by a shallow depression, sinuate opposite the pore, which is situated in front of it above the middle of the side. *Sterna* very finely striolate. *Scobina* absent.

Anal tergite covering the valves but not surpassing them, roundly angled; *valves* lightly compressed, not marginate; *sternite* acutely triangular.

Legs long and slender, with a single seta on the lower edge of each of the first four segments, and a series of three or four on the tarsus, not padded.

Number of segments 50.

Length 51 millim., width 4.

A single male from Wokan Dobbo (Aru Island).

This species falls into the same category with *Sp. Goësi* of Porath, but the sculpturing is much finer and the colouring very different.

Spirobolus hæmorrhantus, sp. n.
(Pl. IX. figs. 12, 12 *a*.)

Colour (in alcohol) bright blood-red throughout.

Face smooth; sulcus mesially obsolete. *Pores* 2 + 2. *Eyes* large, with upper inner border angular, separated by a space slightly greater than a diameter. *Antennæ* long and slender, much longer than the face, surpassing the collum.

Collum polished, acutely angled below, and projecting nearly as far as the inferior portion of the second segment. The rest of the segments smooth and polished behind dorsally, at most lightly wrinkled longitudinally, striolate in front. No *scobina*. The lateral striæ extending in front of the transverse sulcus and reaching almost up to the pore; the transverse sulcus obsolete or nearly so, represented by a shallow depression. The *pores* minute above the middle of the side, in front of the transverse sulcus; *sterna* striate.

The posterior end of the body noticeably compressed; the *anal tergite* scarcely covering the valves, which have their borders prominent and deeply compressed; *sternite* large and angular.

Legs long and slender.

Number of segments 55.

Length about 70 millim., width 5·5.

Loc. Ki Dulau (Ki Islands).

This species, of which a single female specimen was obtained, in colouring resembles *Sp. sanguineus* of C. Koch (Die Myriop. i. p. 16, fig. 15). It, however, at least differs in its long legs and antennæ and prominent anal valves.

EXPLANATION OF PLATE IX.

Fig. 1. *Strongylosoma Gervaisii* (Lucas). Dorsal view, × 1½. In this figure the anterior angles of the keels are too squared and the legs are wrongly placed and wrong in number.
Fig. 1 *a.* Ditto. Left copulatory foot from below.
Fig. 2. *Strongylosoma Guérinii*, Gerv. Left copulatory foot from below.
Fig. 3. *Stenonia tuberosa*, sp. n. Keel of the twelfth segment from above.
Fig. 3 *a.* Ditto. Anal segment from above.
Fig. 3 *b.* Ditto. Copulatory foot from below.
Fig. 4. *Iulus solitarius*, sp. n. Anal segment from the side.
Fig. 5. *Iulus tristani*, sp. n. Anal segment from the side.
Fig. 5 *a.* Ditto. Part of segment to show position of pore.
Fig. 6. *Spirostreptus Moseleyi*, sp. n. Lateral view of head and collum, ×.
Fig. 6 *a.* Ditto. Lateral view of anal segment.
Fig. 7. *Acanthiulus Murrayi*, sp. n. Lateral view of anterior end of body, ×.
Fig. 7 *a.* Ditto. Lateral view of two of the middle segments.
Fig. 7 *b.* Ditto. Lateral view of posterior end of body.
Fig. 8. *Spirobolus dorsalis* (Le Guillou). Lateral view of head, ×.
Fig. 9. *Spirobolus digrammus*, sp. n. Lateral view of head and collum, ×.
Fig. 9 *a.* Ditto. Lateral view of anal segment, ×.
Fig. 9 *b.* Ditto. Anterior view of copulatory feet.
Fig. 10. *Spirobolus challengeri*, sp. n. Lateral view of head and collum, ×.
Fig. 10 *a.* Ditto. Lateral view of anal somite, ×.
Fig. 10 *b.* Ditto. Third leg of male.
Fig. 10 *c.* Ditto. Anterior view of copulatory feet.
Fig. 11. *Spirobolus flavo-collaris*, sp. n. Lateral view of anal segment, ×.
Fig. 11 *a.* Ditto. Anterior view of copulatory feet.
Fig. 12. *Spirobolus hæmorrhantus*, sp. n. Lateral view of head and collum, ×.
Fig. 12 *a.* Ditto. Lateral view of anal segment, ×.

XVII.—*The Influence of Light on the Coloration of Crustaceans.* By A.-E. Malard[*].

M. Martin has recently drawn the attention of our Society to a peculiar case of albinism which he had studied in a lobster

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[*] Translated from the 'Bulletin de la Société Philomathique de Paris,' 8ième série, t. iv. no. 1 (Paris, 1892), pp. 24-30.

observed at St.-Vaast-la-Hougue. In this lobster the absence of pigment did not extend to the eyes, which had preserved their ordinary colour. This phenomenon is not confined to the lobster, but seems to be even of very frequent occurrence in other crustaceans, such as the common edible crab (*Cancer pagurus*) *, in which I have met with very numerous examples of it in the young individuals living beneath the stones of the old oyster-beds near the Isle of Tatihou.

This more or less complete absence of pigment seems to be related to the nature of the habitat of these animals; the fossorial crustaceans, such as *Gebia*, *Axia*, and *Callianassa*, are almost entirely white, and the greater portion of those which live in grottos or crannies of rocks likewise assume similar tints. In the lobster especially considerable differences of hue have been observed by Mr. E. Lovett † in the neighbourhood of the Channel Islands; he has described one specimen in particular, which was "of a pale lavender," with a mauve patch on the cephalothorax, and the chelæ of a bright pale blue. This lobster, which had been sent to him alive by M. Sinel, of Jersey, was still living when he examined it: it was a female with eggs. Mr. Lovett also mentions other colours in the lobster—white spotted with blue, "dappled blue and grey," uniform grey, and finally a curious variety of a pale reddish colour with the antennæ "of a decided bright red." It was maintained at a certain period by Bell that the variations in colour are purely local, each race of lobster thus having a peculiar facies, so much so that a Jersey lobster would be distinguished at once from a French one; the fact in itself is certainly true, but only arises from the different conditions of medium which the animals meet with at different places. As is remarked by Lovett, the coloration must be related to the depth of the water, which allows more or less light to penetrate, and also to the number of the grottos and natural crannies, which, as we know, are very numerous at certain points of the coast of the Channel Islands, as, for instance, in Sark.

I therefore think that these cases of pseudo-albinism in lobsters, such as that of the roseate specimen of Mr. Lovett, the greenish-white individual which has been reported to us by M. Martin, and finally the one which M. Biétrix has told us is under observation at Concarneau, are only normal individuals which have lost their pigment of the cyanic series as

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* Cases of melanism in the same species, due to injury to the derm, are also met with; the crab becomes entirely black, or "charbonné" as the French sailors say.

† 'Zoologist,' ser. 3, vol. viii., 1884, p. 491; and ser. 3, vol. ix., 1885, p. 102.

an actual consequence of the insufficiency of light in the medium in which they have lived.

Far from stopping here, indeed, the influence of light on the coloration of crustaceans is enormous, and we may say that, as an almost general rule, the animals belonging to this class have a tendency to vary the coloration of their bodies according to the coloration of the surrounding medium.

Moreover this chromatic adaptation of the animal to the ambient medium seems to be effected in two different fashions:—

1. *By chemical means*, that is to say, by the modification of a pigment under the direct influence of light.

2. *By physiological means*, that is, by the action of pigment-cells or chromatoblasts working under the influence of light, but indirectly, and by the intervention of a sort of reflex process which actually originates from the eyes of the animal.

Chromatic adaptation is met with in many Copepods, Amphipods, Isopods, and Macrura; it appears to be of less common occurrence in the Brachyura, where it is often replaced by another form of mimicry.

As long ago as 1863 Claus mentioned the changes of colour which are undergone by Copepods belonging to the genus *Sapphirina*. According to this author, in the Copepods of this genus the shield can assume changing colours, which the animal varies according to the media in which it happens to be. One species alone forms an exception to the rule and seems to be devoid of this power of mimicry. In the greater portion of the others the male alone is endowed with this power *. In 1867 an analogous statement was made by Sars with regard to Copepods of the Norwegian coasts †. And, lastly, at a more recent date the same phenomenon was observed by Herrick in the case of *Diaptomus castor* ‡.

The changes of colour in *Squilla* and *Mysis*, under the influence of light, have been known for a very long time; they have formed the subject of recent papers by Weber § and Schmidlein ||, and I merely mention them here in passing.

Among the Isopods the phenomenon is most interesting and easiest to determine in the genus *Idotea*.

In the line of foam and floating sea-weed which distin-

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* Claus, 'Die freilebenden Copepoden,' 1863, p. 35.

† G. O. Sars, 'Histoire Naturelle des Crustacés d'Eau douce de Norvège,' 1867, p. 23.

‡ Herrick, 'American Naturalist,' vol. xvii. p. 381.

§ Weber, Archiv f. mikr. Anat. Bd. xix. pp. 591, 597.

|| Schmidlein, Mittheilungen zool. Stat. Neapel, Bd. i., 1879, p. 513.

guishes the flood-tide from the ebb, it is not unusual to find a somewhat large quantity of a floating weed, *Halidrys siliquosa*, and nearly always there are to be found in this alga considerable numbers of an Isopod Crustacean, *Idotea marina*, which in the general shape of its body, and especially in colour, bears a deceptive resemblance to the brownish elongate elliptical floats of the weed, which have gained the latter its name. This property of chromatic mimicry which is possessed by *Idotea marina* seems to be shared by several other species of the genus. In the case of *Idotea tricuspidata*, a species which is very common in the vicinity of Saint-Vaast, and especially on the tower which serves as a beacon at the Dranguet reefs, it is not difficult to ascertain that the individuals which live in the acorn-barnacle zone are usually of quite a different colour from those living amidst the mussels which cover the base of the tower, and that the latter likewise generally differ in tint from those which are to be met with among the *Ulva*.

P. Mayer has observed these changes of colour in specimens of *Idotea tricuspidata* in one of the tanks at the Naples Zoological Station *, and has found that the same animals change colour according to the objects which surround them, and that in the space of half an hour.

If in some way or other the animal is rendered blind, as by extirpating the eyes for example, this curious adaptation does not take place. Carl Matzdorff †, who has studied very thoroughly the colour-variations of *Idotea tricuspidata*, has shown that these changes are due to chromatoblasts which possess the power of expansion and contraction. The individuals which live upon algæ or hydroids are, according to his observations, in the majority of cases less highly coloured than those which run about on the bottom. Matzdorff even succeeded in causing specimens of *Idotea* to change colour by the experiment of placing them in differently coloured glasses.

Perhaps this adaptation to the general colour of the ambient medium is to be regarded as the cause of the coloration observed in that singular blue pelagic species *Idotea annulata*; at any rate its commensalism with a *Physalia* which is likewise blue would explain this mimicry ‡. Several Læmodipoda, including species of *Proto*, *Protella*, and *Caprella* §,

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* P. Mayer, Mittheilungen zool. Stat. Neapel, Bd. i. pp. 520, 521.

† Matzdorff, "Ueber die Färbung von *Idotea tricuspidata*" (Dissert. inaug., Jena, 1882), Jenaische Zeitschrift, Bd. xvi. p. 158.

‡ Spence Bate, Ann. & Mag. Nat. Hist. ser. 4, vol. i., 1868, pp. 443, 447, pl. xxi. fig. 1.

§ *Proto pedata*, Flem., *Protella phasma*, Latr., *Caprella æquilibra*, Spence Bate and Westwood; Haller, Zeitschr. f. wiss. Zool. Bd. xxxiii. 1879, p. 391.

likewise mimic to a deceptive degree, as I have very often been enabled to observe, the ramifications of the algæ on which they are found. M. E. Chevreux * has already mentioned the singular adaptation which is exhibited in particular by *Caprella acutifrons* to *Cystocira granulata*, the sea-weed which is most often green with yellow spots (as at Les Jonchères, near the Croisic); the *Caprella* is seen to assume the same colour and to cover itself with yellow spots of the same shade and arranged in the same fashion; while at other points of the coast, where the algæ are red, it assumes a uniform brownish-red tint, identical with that of the sea-weed upon which it lives (as at Baie d'Eslandes, near the Croisic). For a long time it was believed that the food of the animal was responsible for these changes in coloration; but in a case like the present it is very evident that, as M. Chevreux remarks, the colour of the *Caprella* cannot be attributed to the nature of its food †, since it is an exclusively predaceous animal. It may be that we ought rather to regard this similitude of form and colour as indicating a sort of rational act on the part of the animal, which seeks a favourable place to hide itself, and actually chooses the alga on account of its shape, not adapting itself as regards colour until afterwards.

In *Hippolyte*, a genus allied to *Palæmon* but of a slightly smaller size, the adaptation of colour seems likewise to be related to the choice of habitat; thus *Hippolyte varians*, which owes its name to these changes of coloration, will be green in *Zostera*, brown in *Fucus*, red in *Floridea*, and transparent or almost transparent when it is found amidst *Antennularia* and *Sertularia*.

Now what is the cause of these changes of colour?

It seems to be the same as that of the coloration of the algæ. As a matter of fact experiments which have been made upon this subject have proved that the same specimen of *Hippolyte* assumes a red tint in complete darkness, while in bright light it becomes a vivid emerald-green colour, and semi-obscurity renders it brown. These experiments, which I have myself repeated, would appear decisive. I am bound, however, to state that I have met with a case which strangely complicates the question.

Thanks to the courtesy of the Board of Bridges and Highways (Buoying Service of the Arrondissement of Cherbourg), and especially to the extreme kindness of M. Rouland, who is

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* E. Chevreux, 'Les Plages du Croisic,' par Adrien Dolfuss, pp. 9 and 11.

† This remark had already been made in the case of *Idotea* by Möbius, Bericht Exped. 'Pommerania,' p. 121.

especially intrusted with this service, I have been enabled for several years past to be present at the picking up of the buoys included in the district of La Hougue: upon one of these it was my fortune to observe an immense quantity of *Comatula* (*Antedon rosacea*), with which the chain of the buoy was literally covered.

These specimens of *Comatula* were of three very distinct colours—more or less deep violaceous red, orange-yellow inclining towards saturn-red, and, lastly, alternately white and red with whitish pinnules. Now I was not a little surprised at observing along the chain of the buoy specimens of *Hippolyte* apparently living side by side with the feather-stars, which they in many cases clasped with their limbs, and agreeing, at least in the majority of instances, so closely with their neighbour in colour that it became difficult to perceive them.

The fact, strange as it is, is not unique. Lucien Joliet has recorded a similar faculty in a Mediterranean *Pontonia* living as a commensal with *Diazona*; this *Pontonia*, which is allied to *P. tyrrhena* and which Joliet has described as a new species under the name *P. diazonæ* *, also bears a deceptive resemblance to the *Diazona*; the transparency of its body blends with the hyaline jelly of the colony, and the yellow spots with which its thorax, abdomen, and chelæ are marked harmonize so perfectly with those of the Ascidian itself, that it becomes impossible to perceive its presence so long as it remains upon its host.

Specimens of *Palæmon* also exhibit variations in colour according to the nature of the bottom on which they are found, becoming green when the bottom is covered with *Zostera* and grey or reddish yellow when the bottom is of sand.

Some years ago M. Georges Pouchet made some very interesting observations upon this subject †. Taking some earthenware vessels coloured black and white inside, he placed in them for the purpose of observation some specimens of *Palæmon* of medium size (3 to 4 centim. in length), which experience had taught him to be most readily subject to variations of colour. These prawns, which on leaving the fishermen's nets are usually of a roseate or faint lilac tint, become colourless, or at the most faintly yellowish, in the vessels with a white bottom; while in the black vessels they become, on the contrary, dark brown.

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* L. Joliet, "Observations sur quelques Crustacés de la Mediterranée," Arch. Zool. expér. t. x. p. 118.

† G. Pouchet, 'Journal d'Anatomie et de Physiologie,' 1872, t. iv. pp. 401-407; C. R. Acad. Sc. Paris, 20 mai, 1872.

The change of colour from the pale to the dark condition occupies but a few minutes; it is different with regard to the opposite process. During the disappearance of the deep reddish-brown tint to become pale yellow and almost transparent the observer noticed that the animal passed through an intense deep blue stage.

M. Pouchet has furnished the explanation of these phenomena [*] by showing how the action of two kinds of pigments took place in them; on the one hand the pigments of the xanthic series (red, orange, and yellow) by the action of the chromatoblasts, on the other the pigments of the cyanic series generally free and in solution. The removal of the eyes produces in *Palæmon* the same effect as a black bottom [†].

In certain Brachyurous Crustaceans we again meet with facts of the same kind; but here they are less general and not so numerous. Fritz Müller [‡] mentions an instance in a Brazilian species of *Gelasimus* which is of a uniform greyish-brown colour in the female. In the male of this *Gelasimus* at the breeding-season the posterior portion of the cephalothorax is of a pure white, while the anterior region assumes a rich green colour, passing into dark brown; in the event of danger and on the animal being alarmed its colours are subject to modification in a few minutes, the white becoming dirty grey or even black and the green losing all its brilliancy. Not until we come to *Carcinus mœnas* do we find that similar facts have been reported; I have myself often observed that the crabs living upon a bottom clothed with *Ulva*, as at the mouth of the Serre, near St.-Vaast, for example, when angry have a more decidedly green tint on the dorsum of the cephalothorax than those which are met with among the stony bottoms of the old oyster-beds and in the *Laminaria*-zone, where they assume olivaceous hues, passing into dirty yellow and brownish red, a shade which is in perfect agreement with the general tone of the bottom. Messrs. Carrington and Lovett [§], in recording analogous observations, state that they have been able to study the mechanism of the phenomena in the tanks of the Westminster aquarium; here again the facts observed are probably due to the action of chromatoblasts.

I do not know whether the chromatoblasts also play a similar part in the Mediterranean *Lambrus*, the curious

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[*] C. R. 1878, t. lxxxvii. pp. 302-303.

[†] M. S. Jourdain has since shown that by removing the eyes and leaving the animal in the dark a red coloration is always obtained.

[‡] According to Darwin, 'The Descent of Man,' French edition, p. 361 [2nd English ed., 1883, p. 271.]

[§] Carrington and Lovett, 'Zoologist,' 1882, pp. 12 and 14.

mimicry of which has been described by M. de Varigny in the 'Revue Scientifique'[*]; it appears to me that this is probably the case, as also in *Portumnus variegatus*, which disappears almost completely upon coarse granitic sand, as I have myself been able to observe. Be that as it may, we see from these examples that concealment by isochromatic adaptation seems to be a very widely spread fact in the different orders of Crustacea, and that albinism in these animals appears to be only a particular case of a very much more general phenomenon of chromatic adaptation to the medium.

XVIII.—*Observations upon* Amœba, *with especial reference to the existence of an apparent Micro-nucleus in that Organism.* (Preliminary Communication.) By JOHN E. S. MOORE, A.R.C.S. (from the Huxley Research Laboratory, R. Coll. Sci. Lond.).

[Plate XII.]

THROUGH the laborious investigations of Maupas, Bütschli, Hertwig, and others we are to-day pretty well acquainted with the minute structural peculiarities and life-history of the ciliate Protozoa. Regarded in the light of single cells these little beings present points of structure at once both strikingly different and similar to those apparent in the cells that build up the Metazoan tissues.

The karyokinetic division of the micro-nucleus ("Nebenkern," "endoplastule," "nucleolus") in the ciliate Infusoria is undoubtedly strictly comparable, step by step, with the similar process apparent in the cells of higher forms; but the coexistence of this structure itself with the macro-nucleus, which divides akinetically, is something totally unlike those conditions which ordinarily present themselves in Metazoan cells.

Our knowledge of the multitude of structures included under the somewhat comprehensive title of "Nebenkern" in the Metazoa is still in a sufficiently unedifying condition to render it impossible to say whether those remarkable bodies met with in the gland-cells of many animals, *i. e.* in the cells actively secreting, are normal or parasitic, or whether in such cells we may not have to deal with a third structure besides the

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[*] de Varigny, 'Revue Scientifique,' 3^{e} série, t. x. p. 92, 2^{e} sem., 1885.

nucleus and attraction sphere, which may well retain the name of "Nebenkern"*.

In May last I succeeded in adducing evidence in support of the view, first initiated by Flemming I believe, that the karyokinetic division of a cell is in reality an expression of two metamorphoses, each to a certain extent independent of the other †: one affects the attraction-sphere and the dividing central bodies, the other the nucleus and the dividing chromosomes. And it is probable that this apparent duality in the metamorphosis may have had much to do with the modern conception that the protozoan micro-nucleus is more or less equivalent to the metazoan central body, and the metazoan chromatic element to the protozoan macro-nucleus ‡.

I am not of this opinion, for I fail to see how a structure presenting all the features of a karyokinetic division, such as is seen in the micro-nucleus of a *Paramæcium* or a *Colpidium*, can be compared with the central body of a cell, metazoan or other.

That the great macro-nucleus, where it exists in the Infusoria, is intimately related in some way or other to the digestive activity of the animal seems highly probable. Indeed it is difficult to see what other functions could be assigned to it; and the Ciliate as a single cell will have to perform all those secretive operations which in more highly specialized organisms would be told off to particular glandular organs §.

Thus it becomes possible that the existence of the "Nebenkern" in many gland-cells of the Metazoa (if that structure can be shown to be there normal) may offer an analogy to that differentiation of the nuclear elements apparent in the ciliate Infusoria. Whatever be the ultimate solution of

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* See "Contributions to Morphol. and Physiol. of the Cell," Macallum, Trans. Canadian Institute, vol. i. pt. 2; Steinhaus, "Ueber parasitäre Einschlüsse in den Pancreaszellen der Amphibien," Ziegler's Beiträge zur Path. Anat. und zur Allgem. Path. Bd. vii. p. 367; Nussbaum, "Ueber den Bau und die Thätigkeit der Drüsen," Arch. für mikr. Anat. Bd. xxi. p. 296.

† Unpublished paper in the hands of the editor Quart. Journ. Micr. Sci.

‡ *Cf.* H. E. Ziegler, 'Biologisches Centralblatt,' Bd. xi. nos. 12 and 13, pp. 372–389; and Bütschli, "Ueber die sog. Centralkörper der Zelle und ihre Bedeutung," Verhandl. d. Naturhist.-med. Vereins zu Heidelberg, Bd. iv.

§ This view receives some support from a consideration of the multinucleate parasite *Opalina*. Here, where there is no need for digestive activity, as the animal is immersed in already digested food-material, we find a corresponding simplification of the nuclear elements, *all* of which present the micro-nuclear karyokinetically dividing structure.

these problems, it would be interesting to find anything comparable to such nuclear differentiation in the other Protozoa.

Turning to the Rhizopods, we find a great variety of nuclear conditions; for example, those described by Gruber in a compendious summary published in the 'Zeitschrift für wissenschaftliche Zoologie' *, and, again, in his 'Studien über Amöben' †, where there is an admirable description of the mono- and multinucleate forms of Amœbæ, of the great diffused nucleus of *A. proteus*, and of the numerous vesiculate nuclei of *Pelomyxa*.

The most interesting thing, however, about these nuclei seems to be the fact that whereas the multinuclei of *Pelomyxa* divide by a process equivalent to karyokinesis, the great diffused nucleus of *A. proteus*, according to the beautiful figures of Schulze and others, divides akinetically in the strictest sense of the term. So also the primary division of the nuclear element in *Arcella*, when nearing the spore-forming stage, is typically karyokinetic; but whether this process of multiplication is maintained is not apparent.

The numerous nuclear elements in the Heliozoa appear, according to Gruber, to increase in a mitotic fashion, while the duplication of the nuclei in *Euglypha alveolata* is represented as proceeding by more than one method.

In an interesting paper in the 'Zeitschrift für wissenschaftliche Zoologie' ‡ Verworn describes in *Difflugia lobostoma* the conjugation process and the existence of corpuscles answering to the micro-nuclei of the Ciliata. Of these structures he says:—"Neben den Individuen, welche die obenbeschriebenen normalen Kernverhältnisse zeigten, fanden sich sehr häufig auch einzelne lebende Exemplare mit ganz abweichendem Verhalten. Diese Individuen besassen zwar auch den grossen runden, blassen Kern, mit ganz normalem Aussehen . . . ausser ihm noch einen zweiten, der eine völlig verschiedene Beschaffenheit aufwies;" and further, "Öfter fand ich Konjugationen, in denen, ausser dem normalen grossen Kern, keine kleine Kerne vorhanden waren." He sums up thus: "Dass der Kern eine bedeutsame Rolle bei der Konjugation spielt, indem die Konjugation charakterisirt ist durch das Auftreten je eines kleinen eigenthümlich gestalteten Kerns neben dem gewöhnlichen, der möglicherweise dem Nebenkern der Ciliata Infusorien entspricht, und ferner dadurch, dass diese kleine Kerne der beiden Individuen während der Konjugation in nahe Beziehung zu einander treten."

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* Bd. xl. 1884, pp. 121-152.

† "Eine Mittheilung über Kernvermehrung und Schwärmerbildung bei Süsswasser-Rhizopoden," *ibid.* Bd. liii. 1892, pp. 114-118.

‡ Bd. l. 1891, p. 443, Taf. 18.

From these observations it becomes probable that we shall have to deal, as Verworn himself says, with such bodies related to conjugation in other Rhizopods. At the same time it is probable that the further study of the apparent discrepancies in the nuclear division of these animals may hereafter lead up to very interesting conclusions, with respect to a possible periodicity in the occurrence of direct and indirect division in such forms of life.

Mr. Lister has kindly sent me, through Prof. Howes, the MS. of a paper read before the Linnean Society of London*, in which he demonstrates the very important fact that in the Mycetozoa the numerous nuclei in the streaming plasmodia divide directly till just before the formation of the spores, when the division passes into typical karyokinesis.

Of the life-history of the Rhizopods we know in reality very little, and it seems to me highly probable that much of the apparent confusion with respect to their direct and indirect division may be due to a possible periodicity in their recurrence.

During the examination of some Amœbæ last autumn I became struck with the regularity in appearance and persistence of a small granular body, usually near the nuclear element, and in its general relationships very like a microcorpuscle during certain phases of its evolution (Pl. XII. fig. 1).

Although loath to enter into a description of a new structure where we have already descriptions and structures enough to last for half a century, I would state that this body appeared to those who saw it a definite entity, and that it showed a remarkable tendency, when displaced in the living animal by the pressure of the cover-glass or other means, to return eventually to its position beside the nucleus.

It did not stain with picro-carmine, but remained perfectly visible after fixing with either gold or platinum chloride (fig. 1); and it could be stained slightly with orange, as was the case with Verworn's corpuscle in *Difflugia*. Flemming's fluid rendered it nearly invisible, on account of the induced contraction; while no better results were obtained with either mercuric chloride or acetic acid. Indeed, it was much best seen when the animal was in full activity (figs. 2, 3).

Of both the significance and metamorphosis of this body I am absolutely ignorant; and my knowledge is summed up in the assertion that there is a small body of fairly constant appearance near the nuclei of some Amœbæ, and (as those

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* Meeting held December 1st. *Cf.* reports in scientific journals.

originally observed were of large size, and as I have not found it in smaller broods since examined) that it possibly only occurs in certain conditions of activity of the same*.

Respecting the other bodies and granules apparent in Amœbæ I have a few remarks to offer.

Exclusive of matter obviously indigestible, which is rapidly extruded, it appears that the remaining granules may be grouped within three categories: one, containing all those fragments of undigested matter, some of whose original characters remain, and two others of a totally different appearance, viz. a second, containing all those spherical homogeneous globules, usually supposed to be fat (but, as the vast majority of them never blacken with osmic acid, this can hardly be the case), and a third, including the so-called crystalline bodies (concretions of Ray Lankester) †.

The origin and significance of the two latter remain still somewhat enigmatical. Considerable light, however, may be thrown on the inter-relations of the bodies in question if an active Amœba be ruptured under the weight of the cover-glass (which, if the animal be surrounded by clear water, usually occurs in from ten to fifteen minutes). If the issuing matter as well as that remaining, now relieved of pressure, be watched under a high power, not only are the more conspicuous masses of little-digested material seen to be surrounded with the usual vacuoles of ingestion, but a vast number of other vacuoles make their appearance, of all sizes, down to one just sufficient to include the smallest apparent concretions (fig. 9). Both the spherical globules and the so-called crystalline bodies are seen to occupy small vacuoles and to issue with them into the surrounding water.

During the later stages of digestion many fragments of nutritious matter bear a closer and closer resemblance to these globules, and it is possible to arrange complete series extending (i.) from the undigested food on the one hand to the homogeneous spheroids on the other (figs. 4–8), and (ii.) from these to the so-called crystalline bodies, which are not doubly refractive (fig. 10). As Miss Greenwood has pointed out ‡, the vacuoles about the food-material decrease up to a certain point; and they are, as she thought possible, secondarily acquired.

From these observations it seems that the food, after what

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* It is probable that a body figured by Leidy in his monograph on the Rhizopods (plate v. fig. 8) is identical with that herein referred to.

† Quart. Journ. Micr. Sci. vol. xix. p. 484.

‡ 'Journal of Physiology,' vol. viii. pp. 264, 283.

we may call the primary process of digestion, enters into the condition of the spherical globules, each surrounded by its vacuole; and that these spheroids, gradually decreasing in size, are ultimately worked up into the so-called crystals *.

To the further consideration of this and other questions raised I intend to return at length.

EXPLANATION OF PLATE XII.

Fig. 1. Amœba after treatment with gold chloride. *a*, refractive body (? micro-nucleus).
Fig. 2. Living Amœba. *a*, refractive body.
Fig. 3. Nucleus of living Amœba, showing its relation to the refractive body (*a*) when at rest.
Figs. 4-6. Digesting matter in successive stages.
Figs. 7, 8. Homogeneous spheroids contained in vacuoles.
Fig. 9. Concretionary matters in relation to the small vacuoles.
Fig. 10. Relation between the spheroids and the so-called crystalline bodies.

Figs. 1 and 2 drawn under Zeiss's apochromatic system, oc. 8 compens. obj. 1·4 homog. immers. Figs. 3–10 drawn under same objective, with substitution of oc. 18.

XIX.—*On the probable Sensory Nature of the "Appendix" of the Antennæ of Coleopterous Larvæ.* By Charles J. Gahan, M.A., of the British Museum (Natural History).

Many Coleopterous larvæ are provided with a remarkable structure which is situated upon the distal surface of the penultimate segment of the antennæ. Though this structure has been noticed by more than one writer on Coleopterous larvæ and has been described as an "appendix," an "appendicular joint," a "blunt tubercle," and in other terms, it does not seem to have attracted much attention. At least, no author, so far as I am aware, has attempted to describe its microscopical characters in detail.

Some observations that I have recently made upon the antennæ of the larva of *Pterostichus*—a genus of Carabidæ—have led me to believe that the so-called appendix is in reality a sensory organ. When the antennæ of this larva are examined under the microscope the appendix is seen as a tolerably conspicuous object projecting from the oblique outer (or posterior) surface of the distal extremity of the third segment, its transverse diameter being very little less than

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* Le Dantec has shown the vacuolar fluid of several Protozoa to be acid ('Annales de l'Institut Pasteur,' 1890, pp. 776–791).

that of the fourth or terminal segment. It consists of a short chitinous or semichitinous collar or stalk, supporting a cap composed of a thin transparent cuticular membrane, which appears to be of the same thickness throughout and to be lined by very small cells. The cap is in the form of a short cone with curved sides, and is strengthened at the base where it joins the collar by a narrow and thickened chitinous ring. Lying within the laterally expanded distal portion of the third segment, at a short distance from the base of the collar, I was able to recognize what seemed to me to be a ganglionic swelling of the antennary nerve, containing a number of nerve-cells from which fibres or rods were seen to extend into the collar. These fibres did not seem to pass beyond the chitinous ring, and were only visible when focusing between the upper and lower portions of the ring. In view of the probable auditory nature of the organ I tried to detect the presence of the characteristic auditory rods which are found to be associated with the auditory apparatus in other insects. My failure in this endeavour was perhaps due to the want of a sufficiently high microscopic power. I am inclined, nevertheless, to suspect that within the collar, and just below the ring, rods of this kind may be found. I was also unable to satisfy myself as to the nature of the contents of the cap, though it seemed quite evident that it contained no otoliths. Whether the ring supports a transverse partition is another point I could not satisfactorily determine, though the appearances were rather in favour of believing that it does. These, however, are points that will have to be settled by further investigation. The presence of a nerve-ganglion with fibres passing out to the organ will also, I admit, need confirmation. In the few preparations I was able to make nothing more was attempted than to clear the integument slightly before finally mounting the antennæ in balsam. I regret that, owing to lack of sufficient material, I could not proceed to examine the structure of the organ more thoroughly by means of staining and sectioning. This I hope to be able to do later on.

Should the organ eventually be definitely proved to possess a sensory function little doubt would, I think, arise as to its auditory character. From its position and the way in which it is guarded by some long stiff setæ it would be more or less prevented from coming in contact with external bodies; so that it would be almost impossible for it to function as a tactile process; while, on the other hand, its general structure seems to preclude the idea of its being an olfactory organ. There are, moreover, on the same distal surface of the third segment, as well as at the apex of the antenna, a few very much smaller hair-like structures somewhat similar to those to which an olfactory function has been usually ascribed. One of these, in close proximity to the organ in question, and two at the apex have a shape somewhat like that of a hand-bell. The remaining two at the apex are more or less cylindrical, with rather blunt extremities. Another on the third segment is shorter and broader and seems to have the form of a truncated cone.

It may be mentioned, in conclusion, that the presence of the "appendix" is not confined to the larvæ of a few genera of beetles. According to the observations of Schiödte and of Chapuis and Candèze it seems to be characteristic of the larvæ of Carabidæ, of Chrysomelidæ, and of certain other large families of Coleoptera, and that, though usually placed towards the outer or posterior side of the distal surface of the penultimate segment, it is, in the Staphylinidæ, situated on the anterior side.

The only other species in which I have had an opportunity of examining it was one of *Telephorus*, in which it had the same relation and pretty much the same general structure as in *Pterostichus*, the chief difference being that the chitinous ring, instead of having a uniform width throughout, is narrow at one side and extends upwards, to reach its greatest width on the opposite side. It was first noticed in this larva by the late G. R. Waterhouse, who referred to it as a "process."

Considering, therefore, the widespread existence of this appendix amongst Coleopterous larvæ, and of its very definite localization on the penultimate segment of the antennæ, together with its rather peculiar structure, it seemed to me that some elucidation of its precise nature and meaning was desirable. And even should it ultimately be proved that I have been mistaken in my first observations upon it, there will be some justification for having directed attention to a structure which seems to have been hitherto almost entirely neglected.

XX.—*Classification of the Pelecypoda: Fischer's Families rearranged in accordance with Pelseneer's Scheme.* By B. B. Woodward, F.G.S., F.R.M.S., of the British Museum (Natural History).

The classification of the Pelecypoda has been from the first a matter of great difficulty owing to their comparatively uniform structure.

The characters hitherto employed have been more or less superficial in their nature. Thus the muscular impressions were for a long time solely relied upon; but an arrangement based on the existence of only one or of two adductor muscles, and, in the latter instance, on their relative size, proved unsatisfactory. Nor did the change in favour of the presence or absence of siphons and of a pallial sinus yield any better result; whilst classification based on the form of the foot is now no longer even thought of.

Neumayr, regarding the matter from a palæontological point of view, suggested a system based on the hinge characters*, which, however, does not satisfy the student of living forms.

Fischer, going deeper, made use of the respiratory organs †, but, misled by their external appearance, divided the class into two-gilled and four-gilled groups, ruthlessly sundering closely related families in the process.

Pelseneer it was who first, in 1889 ‡, pointed out the true reading of the Pelecypod gill-structure and founded on the morphology of that organ a classification which, though doubtless not final in minor details, promises to be by far the best of any.

It is extremely interesting to note that Pelseneer forestalled by but a very short time an independent worker, Ménégaux, who had arrived at almost precisely similar conclusions §.

Yet another classification has recently been proposed by Prof. C. Grobben ‖. In this the external form of the gill is taken as a primary character, whilst the hinge is relied upon as the secondary basis of the arrangement. The result,

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* "Zur Morphologie des Bivalvenschlosses," Sitzb. k. Akad. Wissensch. Wien, Bd. lxxxviii. Abth. i. (1884), pp. 385–419. The amplification of which, so far as completed at the time of his death, appeared in the Denkschr. vol. lviii. (1891), pp. 701–801.

† 'Manuel de Conchyliologie' (1886–87).

‡ "Classification phylogénétique des Pélécypodes (communication préliminaire)," Bull. Scient. France et Belgique, tom. xx. (1889), pp. 27–52; the complete memoir was published as "Contribution à l'étude des Lamellibranches," Arch. Biol. (Liège), xi. (1891), pp. 147–312, 18 pls.

§ In fact his first note, "Sur la Branchie des Lamellibranches et sur la comparison avec celle des Scutibranches," Bull. Soc. Philom. sér. viii. tom. i. (1889), pp. 137–144, was elicited by Pelseneer's "preliminary communication," the full text having been sent in as a Thesis, which was afterwards published under the title 'Recherches sur la circulation des Lamellibranches Marins' (4to, Besançon, 1890).

‖ "Beiträge zur Kenntniss des Baues von *Cuspidaria* . . . . nebst Betrachtungen über das System der Lamellibranchiaten," Arb. Zool. Inst. Univ. Wien, x.; the latter section also appeared in Zool. Anz. xv. (1892), pp. 371–375, whilst diverse translations are given in Journ. R. Micr. Soc. 1892, p. 772, and Nat. Sci. ii. p. 9.

however, as set forth by the author will hardly commend it to practical malacologists.

Pelseneer's scheme appears so decidedly in advance of the others that after consultation with my friend and colleague Mr. E. A. Smith it has been decided to adopt it in future volumes of the 'Zoological Record,' retaining Fischer's families as far as possible for the present for the sake of convenience in reference.

Since, however, the 'Zoological Record' does not admit of the new arrangement being shown in its entirety, it seems fairer that it should in the first instance be published where it will be available to all in a handy form.

Hitherto only the relationship of the main groups has been published, and that in a "tree" which should be studied in conjunction with the linear arrangement that here follows; for in the latter of course the essential features of the "tree" cannot be reproduced, though some help is sought to be given by "indenting" those families which lie on the divergent branches and placing them between "rules," after the method familiar in a railway time-table.

The three families not in Fischer are printed in italics.

Class **PELECYPODA.**

Order I. SEPTIBRANCHIATA.

Fam. 1. *Poromyidæ* (*Poromya* and *Silenia*).
2. Cuspidariidæ.

Order II. EULAMELLIBRANCHIATA.

Subord. i. Anatinacea.

Fam. 3. Clavigellidæ.
4. Pholadomyidæ.
5. Præcardiidæ.
6. Grammysiidæ.
7. Anatinidæ (excepting *Poromya*).
8. Arcomyidæ.
9. Ceromyidæ.
10. Lyonsiidæ (excepting *Silenia*).
11. Verticordiidæ.
12. Chamostreidæ.
13. Pandoridæ.

Subord. ii. Pholadacea.

Fam. 14. Teredinidæ.
15. Pholadidæ.
16. Gastrochænidæ.

Subord. iii. Myacea.

Fam. 17. Solenidæ.
18. Glycymeridæ.
19. Myidæ.
20. *Lutrariidæ.*

Subord. iv. Cardiacea.

Fam. 21. Radiolitidæ.
22. Hippuritidæ.
23. Caprinidæ.
24. Monopleuridæ.
25. Chamidæ.
26. Tridacnidæ.
27. Lunulicardiidæ.
28. Cardiidæ.

Subord. v. Veneracea.

Fam. 29. Psammobiidæ.
30. Cyrenellidæ.
31. Rangiidæ.
32. Cyrenidæ.
33. Glaucomyidæ.
34. Petricolidæ.
35. Veneridæ.
36. Pachydomidæ.
37. Cyprinidæ.
38. Megalodontidæ.

Subord. vi. TELLINACEA.

Fam. 39. Scrobiculariidæ.
40. Tellinidæ.
41. Donacidæ.
42. Cardiliidæ.
43. Mesodesmatidæ.
44. Mactridæ (excepting *Lutraria*).

Subord. vii. SUBMYTILACEA.

Fam. 45. Galeommidæ.
46. Erycinidæ (excepting *Montacuta*).
47. Kellyellidæ.
48. Crassatellidæ.
49. Tancrediidæ.
50. Unicardiidæ.
51. Ungulinidæ.
52. Lucinidæ (including *Montacuta*).
53. Astartidæ.
54. Carditidæ.
55. Cardiniidæ.
56. Ætheriidæ.
57. Unionidæ.
58. *Dreissensiidæ.*
59. Modiolopsidæ.

Order III. PSEUDOLAMELLIBRANCHIATA.

Fam. 60. Ostreidæ.

61. Aviculidæ.
62. Prasinidæ.

63. Pectinidæ.
64. Limidæ.
65. Spondylidæ.
66. Dimyidæ.

Order IV. FILIBRANCHIATA.

Fam. 67. Mytilidæ (excepting *Dreissensia* and *Dreissensiomya*).

68. Trigoniidæ.

69. Arcidæ.

70. Anomiidæ.

Order V. PROTOBRANCHIATA.

Fam. 71. Solenomyidæ.

72. Nuculidæ.

XXI.—*Notes on* Apteryx Haasti.

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

GENTLEMEN,—In the last number of the 'Annals,' page 43, I observe an article on *Apteryx Haasti*, Potts, by the Hon. Walter Rothschild. "Mr. Forbes," it affirms, "has expressed it as his opinion that *Apteryx Haastii* is a natural hybrid between *A. australis* and *A. Owenii*. I have paid much attention to this question as well as to the study of this genus generally," &c.

I am not sure whether or not I am the "Mr. Forbes" referred to; but as I am led to believe that I am, I hope you will grant me the privilege of making a few observations on Mr. Rothschild's note. I am surprised, in the first place, to have opinions that I privately entertain publicly criticized; for, so far as I can charge my memory, I am not aware of having ever committed to print my opinions upon the species of *Apteryx*. I should be glad, therefore, if Mr. Rothschild will be so kind as to give me a reference to the publication in which I have made the statement that *Apteryx Haasti* "is a natural hybrid of *A. australis* and *A. Owenii*." Having had charge, however, of the type specimens of *A. Haasti* for some years, I naturally made a somewhat careful examination of them; and the opinion I formed then I still retain, that *A. Haasti* is most probably a natural hybrid between the two above-named species. This, however, is, I believe, the first occasion on which I have expressed *in writing* this opinion. The type specimens of this bird in the Canterbury Museum were obtained on the west coast of the South Island, and from the region in which *A. australis* and *A. Oweni* both abound. I am therefore again surprised to read Mr. Rothschild's affirmation that *Apteryx Haasti* is known only from the *North* Island, as on page 330 of his 'Birds of New Zealand' (2nd ed. vol. ii.) Sir Walter Buller has the following remark in reference to these very specimens:—"These [specimens of *A. Haasti*] were obtained on the high ranges above Okarita, on the west coast of the South Island, where, according to the resident natives, the large Grey Kiwi is tolerably common." Mr. Rothschild bases his belief in the distinctness of *A. Haasti* as a good and pure species on its geographical distribution, on the size of the bird and the length of its beak, and on variations in its cæcum. As I have shown, the inference from its distribution signally fails. It is well known, too, that the various species of *Apteryx* vary greatly in size. In the Canterbury Museum, N. Z., there is a very large specimen of *A. australis*, nearly equalling the *Apteryx maxima* belonging to Mr. Rothschild, as I remarked to one or two of my friends at the recent meeting of the Zoological Society at which it was exhibited. Before leaving New Zealand I had also, through the kindness of Mr. A. Hamilton, of the Otago University, Dunedin, an opportunity of examining a large collection of *Apteryx* crania (both *australis* and *Oweni*) discovered in one of the limestone caves of Otago, and was particularly struck by the great variability in length and strength of the beaks, some being remarkably long. I hope Mr. Hamilton will ere long favour ornithologists with a description of these remains. In regard to the variations observable in the cæcum, does not their divergence in the two sexes of *A. Haasti* afford a presumption *in favour* of hybridity? If it were a true species, should we not look for a close agreement between the internal anatomy of the male and female?

Further, Mr. Rothschild states that the native name for

Apteryx Haasti is "Roa-Roa" and it is not known by the name of "Kiwi." The name "Roa-Roa," however, is applied to several species of *Apteryx*, and specially to *Apteryx maxima* of Stewart Island. I would, however, again refer Mr. Rothschild to Sir Walter Buller's second volume, p. 330, where he will find that the native names for the *South-Island* types in Christchurch, N. Z., are both "Roa" and "Roa-Roa" as well as "Kiwi Karuai."

To the best of my knowledge *Apteryx Haasti* has hitherto been found *only* in the *South Island*, and in that district alone in which *Apteryx australis* and *A. Oweni* both occur, which so far seemed very significant. Its occurrence in the North Island is to me a new and most interesting fact, and, if substantiated, would certainly go far to upsetting the opinion I at present hold that *Apteryx Haasti* is a hybrid. Is Mr. Rothschild quite certain of the localities of his specimens and of the accuracy and *bona fides* of his collector? I shall look forward with much interest to learn the actual localities whence have come his specimens, also if the young specimens of *A. Haasti* which Mr. Rothschild has had alive at Tring were reared by him, or if he has had eggs from a pair of these birds when confined by themselves. Does *Apteryx Haasti* occur in the localities in which *A. Bulleri* (=*A. Mantelli*) is found? Or can Mr. Rothschild himself have mistaken large west-coast specimens of *A. Oweni* for *A. Haasti*?

HENRY O. FORBES.

1 Philbeach Gardens,
Jan. 6, 1893.

XXII.—*Natural History Notes from H.M. Indian Marine Survey Steamer 'Investigator,' Commander R. F. Hoskyn, R.N., commanding.*—Series II., No. 1. *On the Results of Deep-sea Dredging during the Season* 1890–91. By J. WOOD-MASON, Superintendent of the Indian Museum, and Professor of Comparative Anatomy in the Medical College of Bengal, and A. ALCOCK, M.B., Surgeon I.M.S., Surgeon-Naturalist to the Survey.

[Continued from vol. ix. p. 370.]

[Plates X. & XI.]

Family **Pasiphaïdæ**.

PASIPHAË, Savigny.

52. *Pasiphaë sivado* (Risso).

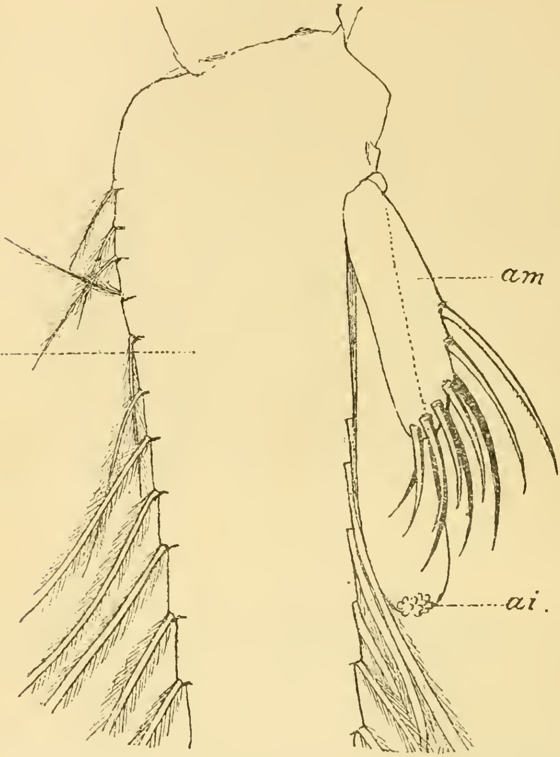
Pasiphaë sivado, *Savignyi*, et *brevirostris*, Milne-Edwards, Hist. nat. des Crust. vol. ii., 1837, p. 426, et Atlas du Règne Anim. de Cuvier.

Crust. pl. xxii. fig. 3; Bell, British Stalk-eyed Crust. 1853, p. 312, woodcut; Heller, Crust. Südl. Europ. 1863, p. 243, pl. viii. figs. 4-6; Wood-Mason, Ill. Zool. 'Investigator,' pt. i., Crust. pl. iii. fig. 6, ♂[*].

Two males were taken on November 29th, 1888, north of Port Blair, Andaman Sea, in 200 fathoms.

They differ from a Mediterranean specimen of the female

Fig. 1.



Pasiphaë sivado (Risso), ♂.—Basal portion of endopodite of second abdominal limb of the right side from in front. *en*, endopodite; *ai*, appendix interna; *am*, appendix masculina; the spines of the hinder row are shaded to distinguish them more clearly from those of the front row. Magnified.

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[*] 'Illustrations of the Zoology of H.M. Indian Marine Surveying Steamer 'Investigator,' under the command of Commander A. Carpenter, R.N., D.S.O., and of Commander R. F. Hoskyn, R.N.'—Part I., Fishes, Plates I.-VII., under the direction of A. Alcock; Crustaceans, Plates I.-V., under the direction of J. Wood-Mason. Published under the authority of the Director of the Royal Indian Marine. Calcutta: printed and sold by the Superintendent of Government Printing. 1892.

in the collection of the Indian Museum in their slenderer form, in the minuteness of the postfrontal spine, which is only about as large as the apical half of that of the female, and in their shorter abdominal pleura. In the female these are longer and squarer, and those of opposite sides are abruptly bent inwards near the lateral margins so as to overlap one another ventrally, completely closing the subabdominal cavity at all events when the abdomen is partially flexed, and entirely concealing from view the four intermediate pairs of appendages, which are laid forwards upon the sternal region, thus forming, there is little doubt, an incubatory cavity for the eggs. In our specimens of the male, which are preserved with the abdomen and its appendages fully extended, the pleura are not bent inwards, being kept straight by the extended limbs, but at each end of some of them a short longitudinal crease is distinctly to be made out, indicating that the male, in common with the female, possesses the power of closing the subabdominal cavity.

The *appendix masculina* is armed at the extremity with two curvilinear rows of slender and moderately curved spine-like setæ, one row slightly in front of the other; the front row, consisting of six spines, commences about the middle of the inner margin and extends to the inner apex of the part; the hinder row, consisting of four, commences opposite to the interval between the third and fourth spines of the front row, extending to the same level.

Total length, from anterior end of carapace to tip of telson, 48 millim.; of carapace, from middle of anterior to middle of posterior margin, 15 millim.; of antennal scale 6·25 millim.; of abdomen, from base to tip of telson, 32 millim.; of its sixth tergum 7·75 millim.; of telson 5 millim.; breadth of thorax across branchial regions 3·5 millim.; of abdomen across hump 3 millim.

53. *Pasiphaë unispinosa*, sp. n.

Pasiphaë unispinosa, W.-M., Ill. Zool. 'Investigator,' pt. i., 1892, Crust. pl. iii. fig. 7, ♀.

Differs from *P. sivado* in the following points:—The body is not quite so strongly compressed. The carapace is longitudinally convex in the mid-dorsal line and is furnished on each side with a blunt lateral carina, which commences just behind the eye and extends downwards and backwards to the hepatic region, whence, after giving off a branch obliquely downwards and backwards towards the inferior margin, it is continued in a nearly straight line along the branchial region almost to the posterior margin; its sides bulge so as to throw the narrow dorsal region into relief as a blunt carina, and its postfrontal spine is rather larger. The abdominal hump appears to be more strongly developed; the sixth abdominal tergum is deeper, more strongly arched both above and below, and is not produced to a spine in the middle of its posterior margin, which, when viewed from above, appears quite straight. In the first pair of legs the basipodite is furnished at the apex with one spine, but the meropodite is unarmed; in the second pair there is also a spine at the apex of the basipodite, but only one on the lower margin of the meropodite. Both eye-peduncles and corneæ are more elongated.

Length, from anterior end of carapace to tip of telson, 57 millim.; of carapace, from middle of anterior to middle of posterior margin, 16·5 millim.; of antennal scale 7·0 millim.; of abdomen, from base to tip of telson, 40·0 millim.; of its sixth tergum 9·2 millim.; of telson 7·0 millim.; breadth of thorax across branchial regions 6 millim.; of abdomen across hump 4 millim.

Two females were taken on April 11th, 1888, 7 miles S.E. by S. of Ross Island, Andaman Sea, in 265 fathoms.

PHYE *, gen. nov.

Differs from *Pasiphaë* in the carapace and abdomen being more or less extensively and distinctly carinated dorsally, in the former being armed in front with a pair of branchiostegal spines, and in the telson being forked at the extremity.

Includes *P. princeps*, S. I. Smith ('Albatross' Crust. 1884, p. 37, pl. v. fig. 2, ♀, et 1886, p. 78, ♂ ♀, Western Atlantic, 444–1342 fathoms); *P. acutifrons*, Sp. Bate ('Challenger' Macrura, 1888, p. 871, pl. cxli. fig. 3, South of Japan, 775 fathoms, and Coast of Patagonia, 245 fathoms); *P. forceps*, A. M.-Edw. (Miss. Sc. du Cap Horn, Crust., 1891, p. 51, pl. vi. fig. 2, Straits of Magellan, 326 metres); and the following:—

54. *Phye Alcocki*, W.-M.

Parapasiphaë Alcocki, W.-M., Ann. & Mag. Nat. Hist. (6) vii., 1891, p. 196, ♂; et Ill. Zool. 'Investigator,' pt. i., 1892, Crust. pl. iii. fig. 5.

From *P. princeps* and *P. acutifrons* it differs in the form of the postfrontal spine (which is thin and foliaceous, terminates abruptly in front in a strongly sinuous and almost vertical edge, and extends nearly to the posterior slope of the carapace

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* *Θρῇτταν ᾗ ὄνομα Φύη.*—Arist., Ath. Pol. 14.

as a backwardly diminishing carina, which is sharp and foliaceous in its anterior half and blunt in its posterior half); in the pigment of the eyes being brown instead of black; in the sixth abdominal tergum alone being distinctly carinated; and probably in the relative proportions of its different parts.

From *P. princeps* it differs in the telson being shorter than the sixth abdominal somite and in the meropodites of the first pair of legs being armed with three spines upon their lower margin.

From *P. acutifrons* it differs very markedly in the form of the postfrontal spine, and, according to Spence Bate's figure, in the strongly arched outer margin of the antennal scale.

From *P. forceps* it differs no less markedly than from *P. acutifrons* in the form of the postfrontal spine, and, besides, in its more unequal and absolutely much longer antennulary flagella; in the notch at the extremity of the telson being acutangular and fringed to the bottom on each side with minute spinules; in the point of the fixed arm of the claws of the first pair of legs being simple; and probably in other details.

Of the three, *P. princeps* is the one to which it is most nearly related.

Length, from middle of frontal margin to tip of telson, 59 millim.; of carapace, from middle of frontal to middle of posterior margin, 18 millim.; of abdomen, from base to tip of telson, 41 millim.; of telson 8 millim.; of sixth abdominal somite 9·75 millim.; of antennal scale 8 millim.

PARAPASIPHAË, S. I. Smith.

a. Antennal and branchiostegal spines absent...... Sect. *Parapasiphaë.*

The following species come into this section:—

1. *Parapasiphaë sulcatifrons*, S. I. Smith, 'Albatross' Crust., 1884, p. 40, pl. v. fig. 4, pl. vi. figs. 1-7, ♂ ♀. Western Atlantic, 515 to 2949 fathoms.
2. *Parapasiphaë cristata*, id. ibid. p. 44, pl. v. fig. 3, ♀. Western Atlantic, 1628 fathoms.

b. Antennal and branchiostegal spines present ...... Sect. *Eupasiphaë.*

To this section belong the following:—

55. *Parapasiphaë* (*Eupasiphaë*) *latirostris*, W.-M.

Parapasiphaë latirostris, Wood-Mason, Ann. & Mag. Nat. Hist. (6) vii. 1891, p. 196, ♀.

We give a figure of this fine species the size of nature (fig. 2, p. 166).

56. *Parapasiphaë* (*Eupasiphaë*) *Gilesii*, sp. n.

Parapasiphaë Gilesii, Wood-Mason, Ill. Zool. 'Investigator,' Crust. pl. iii. fig. 8, ♀, × 2.

Rostrum slender, acute, awl-shaped, slightly compressed, slightly curved, ascendant, extending by rather more than one third of its length beyond the extremities of the eye-peduncles. Postfrontal ridge cristiform, armed throughout from the base of the rostrum to the posterior slope of the carapace with minute forwardly-inclined denticles, the first of which is placed well on the base of the rostrum and is more than double the size of any of the rest, which are subequal;

Fig. 2.

Parapasiphaë latirostris, nat. size.

it is divided by a distinct cervical groove into two lobes, the anterior of which is somewhat the higher and longitudinally somewhat the more convex of the two.

The anterior margin of the carapace bears on each side two spines—the one smaller, situated just behind the edge of the orbital sinus, and answering in all probability to the antennal spine of the Penæidea; the other larger, which arises from the margin itself, opposite to the insertion of the antenna, and is, there is little doubt, a true branchiostegal spine. About midway between the branchiostegal spine and the obtuse extra-orbital angle on each side the anterior margin projects a process of about the same size and shape as the latter, and hence presents an angularly sinuous or zigzag outline between the two spines. The branchiostegal spine is continued backwards along the side of the carapace as a well-defined slightly upwardly concave ridge; this is subacute nearly as far as the hepatic region, and thence blunt to its abruptly upcurved extremity near the hinder end of the carapace; it curves upwards for a short distance from its origin, then descends almost imperceptibly to about the middle of its length, whence it rises by a no less gentle ascent to its upturned extremity; it emits three branches—one, faint, from the hepatic region, upwards and forwards towards a point in the anterior margin which is just internal to the antennal spine; a second, as well-defined as itself, from the point at which it is intersected by the cervical groove, straight downwards and backwards towards the inferior margin; and a third, equally well-defined, from a point a little to the rear of that from which the second is given off, upwards, inwards, and backwards, so as to mark out the upper boundary of the subjacent branchial chamber.

The terga of the abdominal somites are increasingly carinate from the second to the fourth; the carina of the fourth is faintly notched, as in *Acanthephyra*, and terminates posteriorly in a strong spine. Those of the remaining somites are transversely rounded.

The telson, which wants its extreme tip, agrees, as far as it is preserved, with the description of that of *Parapasiphaë sulcatifrons*, S. I. Smith.

The eye-peduncles are compressed from above downwards and bear on the inner and upper margin, at a short distance from the edge of the cornea, a small conical tubercle, which is directed inwards and slightly forwards; the compressed hemispherical and distinctly faceted cornea occupies the whole width of their apex, upon which it is somewhat obliquely set; and their pigment is bright brown in spirit.

The peduncle of the antennules agrees with Prof. S. I.

Smith's description of that of *P. sulcatifrons*; but the inner flagellum of these organs is only about one half the length of the carapace measured from the apex of the rostrum to the middle of the hinder margin in a straight line, and less than one third the length of the outer flagellum; this is much stouter than the inner and expanded at the base in the usual manner.

The thoracic limbs differ in the relative proportions of their parts and in armature from those of *P. sulcatifrons* to an extent and in a manner which will be best appreciated by comparison of the figures of the two species.

Length, from apex of rostrum to end of caudal appendages, 49 millim.; of carapace, from apex of rostrum to middle of hinder margin, 19·5 millim.; of outer flagellum of antennules 34·5 millim., of inner 9·5 millim.; of antennal scale 7·25 millim.; length of abdomen from base to end of telson 27·5 millim., of its sixth somite 5·5 millim., of telson (tip wanting) 6·5 millim.

A single female was taken on Jan. 15th, 1888, off Cinque Island, Andaman Sea, in 650 fathoms.

PSATHYROCARIS, gen. nov.

Psathyrocaris, Wood-Mason, Admin. Rep. Marine Survey of India, 1890–91, p. 19.

Integument thin and delicate; all appendages and processes of extraordinary fragility.

Body moderately compressed.

Carapace shortly rostrate, longitudinally carinate for a longer or shorter distance in backward continuation of the dorsal crest of the rostrum; its anterior margin unarmed—antennal and branchiostegal spines being absent,—at first broadly arched, then narrowly emarginate between the blunt triangular extraorbital angle and the antero-lateral angle on each side; its sides distinctly ridged, the ridging varying with the species; the efferent portion of the branchial chamber relatively spacious.

Antennules and antennæ broken off in all the specimens near the base.

Eye-peduncles and corneæ depressed, the latter hemispherical, occupying the whole width of the extremities of the former, on which they are set quite square. The usual papilla is present close to the edge of the corneæ on each side.

Mandibles (Pl. XI. fig. 1) of typical Pasiphaïdean form, with a very large two-jointed palp.

First maxillæ (Pl. XI. fig. 2) with the inner lacinia (*cx*) pointed and recurved towards the outer (*bp*), and with a small triangular process on the inner margin of the endopodite (*en*) as in *Parapasiphaë*.

Second maxillæ (Pl. XI. fig. 3) with well-developed inner (*cx*) and middle (*bp*) laciniæ, the latter of which is bilobed, thus differing from those of all * previously described genera, in which both laciniæ are reduced to a quite rudimentary condition; and with a relatively very large and powerful scaphognathite, in correlation to the spacious efferent branchial channel.

First maxillipedes (Pl. XI. fig. 4) with well-developed endopodite (*en*) and middle (*bp*) and inner (*cx*) laciniæ, the latter of the two last of which, though decidedly weaker, is nevertheless produced inwards to the same level as the former, and is fairly well fringed, thus also differing from all previously described genera, in which indeed little besides the exopodite of these jaws remains, the laciniæ being both reduced to a more or less scanty fringe of weak setæ and the endopodite to a minute projection of the inner margin of the exopodite, whilst the epipodite when present is smaller (*Parapasiphaë*) or altogether wanting (*Pasiphaë*). The exopodite gives off from its inner margin just below the true apex a pedunculated oval plate, which serves as the occlusor apparatus of the efferent branchial aperture and, in correlation with the large size of that aperture, is much larger than in any other genus.

Second maxillipedes (Pl. XI. fig. 5) almost exactly as in the Penæidea, seven-jointed, the division between the second and third joints being still quite distinct at the edges; furnished with a short tapering exarticulate exopodite (*ex*), which scarcely exceeds the third joint in length; and with a complete podobranchia (*ep* + *br*), thus contrasting strongly with those of previously described genera, in which the corresponding appendages are weaker and but six-jointed, the second + third being indistinguishably fused into one, there is never any trace of an exopodite, and the podobranchia is represented at most by a small epipodite and may be entirely wanting.

Third maxillipedes (Pl. XI. fig. 6) four-jointed †, as in *Pasiphaë*, *Phye*, and *Parapasiphaë*, furnished at the base with a rudimentary epipodite, and, quite close to the base of the second joint (2 + 3 + 4), with a minute tapering exarticulate exopodite, similar to, but much smaller than, that of the second maxillipedes, and lodged in a groove in the side of the joint.

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* Except *Leptochela*, which would appear to have fully developed second maxillæ.

† *Leptochela* has five, and is so far less modified than any other genus.

The first and second pairs of legs are dissimilar both in form and structure.

The first pair is the shorter, and their claws are shaped much as in *Pasiphaë*. The inner edge of the dactylopodite is unarmed, but is raised into a sharp lamellar cutting-edge; that of the prolonged part of the propodite, on the other hand, is armed throughout with minute acicular spines of tolerably uniform size and all slanting towards the apex of the joint.

The second pair is much the longer, and their claws differ in form in the different species and would appear to be unequal on the two sides. The inner edge of both dactylopoditic and propoditic elements of these claws is armed with minute spines similar to those of the first pair, and, in addition, at intervals with much longer ones (three or four times as long) of the same form.

The third and fourth pairs of legs are alike. They are greatly reduced in thickness, but little if anything in length, forming long setaceous filaments of excessive tenuity and fragility.

The fifth pair of legs is the shortest of all and is much stouter than the third and fourth and much slenderer than the first and second; it is, in fact, in point of thickness about intermediate between the two sets of legs. They are set on and directed in the manner which seems characteristic of the family. Their propodite bears at the distal end of the lower surface a conspicuous whisp of longish setæ, which is directed towards the apex of the joint, while the dactylopodite is covered below with a dense brush of short spiny setæ, and is evidently intended to fold back against the propoditic whisp, so as to form therewith a sort of prehensile subchela.

All the legs possess the full number of joints and all are furnished with exopodites. The exopodites of the first pair of legs are small and inconspicuous, but those of the second to the fifth pairs are long and excessively fine articulated setaceous filaments, which form a gradually increasing series to the fourth, the fifth being suddenly much longer and fully equalling in length the third or fourth pairs of legs. They are all very sparsely clothed with long, lax, obsoletely plumose setæ, and are all produced at the base into a little tongue-shaped spur.

The first to fifth pairs of abdominal appendages are remarkable for the enormous inequality of their two branches, as well as for the excessive tenuity of the outer branch, which, in the case of the second pair, is in one species no less than twenty-four times the length of the inner, which is quite minute; the exopodites of the abdominal appendages, in fact, closely resemble those of the legs, differing therefrom only in being somewhat stouter, more distinctly articulated, and more richly provided with more strongly plumose setæ.

Abdomen transversely rounded, not carinate, dorsally.

Telson quadrangular, tapering gradually from base to apex, terminating in a minute fixed median spine and two unequal pairs of articulated lateral spines; its dorsal spines obsolescent.

There are twelve functional branchiæ and two epipodites on each side distributed as follows in *Psathyrocaris fragilis*:—

Somites and their appendages.	Podo-branchiæ.		Arthro-branchiæ.		Pleuro-branchiæ.		
VII.	0 (*ep.*)		0		0	=	0+*ep.*
VIII.	1		0		0	=	1
IX.	0 (*ep.*)		2		0	=	2+*ep.*
X.	0		1		1	=	2
XI.	0		1		1	=	2
XII.	0		1		1	=	2
XIII.	0		1		1	=	2
XIV.	0		0		1	=	1
	1+2 *ep.*	+	6	+	5	=	12+2 *ep.*

Psathyrocaris has hence one more gill—and that a complete podobranchia consisting of plume and epipod attached to the second maxillipedes—than in *Parapasiphaë*, the least modified of the genera so far described, in which the corresponding gill is reduced to a rudimentary epipod.

57. *Psathyrocaris fragilis*, sp. n. (Pls. X., XI.)

Colour in spirit very dark reddish purple or wine-red above, the ventral surface and legs lighter, the thoracic and abdominal exopodites and antennæ colourless.

Thirteen specimens, all more or less broken, though admirably preserved as to their soft tissues, were taken at Station 120, 240 fathoms.

In dealing with a single species it is impossible satisfactorily to define the specific characters, and, as the results of the dredgings carried out during the season 1891–92 contain several additional species, including a fine ovigerous female of one of them, we have thought it better to defer the specific description of the present species until we shall have thoroughly examined our new material. Meantime the characters of the genus will suffice for those of the species, especially as they are accompanied by detailed figures.

EXPLANATION OF THE PLATES.

Plate X.

Fig. 1. *Psathyrocaris fragilis*, ♀, from the left side. Nat. size. Both the legs of the second pair are figured, to show their inequality.
Fig. 2. Rostrum of the same. Enlarged.
Fig. 3. The caudal swimmeret of another specimen, from above. × 3.
Fig. 4. A leg of the fourth pair of another specimen. × 4.
Fig. 5. An abdominal appendage of the second pair of another specimen. × 5.

Plate XI.

Fig. 1. *Psathyrocaris fragilis.* Mandible. × 9.
Fig. 2. First maxilla. × 9.
Fig. 3. Second maxilla. × 9.
Fig. 4. First maxillipede. × 9.
Fig. 5. Second maxillipede. × 9.
Fig. 6. Third maxillipede. × 4·5.

[To be continued.]

XXIII.—Aglia tau, *a connecting-link between the* Ceratocampidæ *and* Saturniidæ, *and the Type of a new Subfamily,* Agliinæ. By Alpheus S. Packard.

In this European Bombycine moth we have a most interesting form surviving side by side with *Saturnia*, which seems to be the most generalized form of its family. *Aglia* appears to be a Ceratocampid in its earlier larval stages, the caterpillar in its final stage, however, and the moth being closely related to the Saturnians. It seems quite reasonable to suppose that the Saturnians have directly descended from a form like *Aglia*, and we could scarcely expect a clearer demonstration of the origin of one family from another by direct genetic descent.

The transformations of this form, originally figured in Duponchel and Guenée's 'Iconographie' * (tom. ii.), have been more fully elaborated by Mr. Poulton †.

Having received, through the kindness of Dr. Heylaerts, a young larva of *Aglia tau* in its third stage, I have been able

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* Guenée states that, after attaining its full size, "elle se retire à la surface de la terre, entre des mousses et des débris de végétaux qu'elle attache avec de la soie, et elle s'y change en une chrysalide grosse, courte, d'un brun foncé saupoudré de grisâtre, et dont l'anus est terminé par un faisceau de pointes recourbées."

† Trans. Ent. Soc. London, 1888, pp. 555–568, pl. xvii. figs. 1–7.

to compare it with *Eacles imperialis* in its third stage, which Mr. Poulton could not do for want of specimens. The resemblance between the two genera at this stage is most striking, although the fully-fed larvæ are so different, *Aglia* passing at a single moult (the third and last, this larva only having *four* stages) from one family to another!

We know of no parallel case, or, at least, of one so very striking and conclusive*. Thus the ontogenetic development of this caterpillar epitomizes that of the two families, whereas that of most Bombyces is simply usually only an epitome of that of a subdivision of a family or of a small group of genera.

Aglia tau in its third stage differs from *Eacles imperialis* in its third stage in having a pair of dorsal "horns" on the first and third thoracic segments, *E. imperialis* having only minute ones on the prothoracic segment, while those on the second thoracic segment are as well developed as those on the third segment; those on the second segment are minute; all the "horns" are forked, as in *Eacles*. The dorsal spines on the abdominal segments are simple and minute, like those on the second thoracic segment.

The shape of the head and of the anal legs is much as in *Eacles*, but the suranal plate differs strikingly in being produced into a rather large spinulated spine, a feature not known to exist in any Ceratocampids.

It should be observed in regard to the large size of the prothoracic horns of *Aglia* that those of *Citheronia regalis* are quite well developed, being about two thirds as long as those on the two succeeding segments.

Upon examining the adult of *Aglia* I find that its head and antennæ are closely similar to those of *Hyperchiria io* and the Hemileucidæ † in general; the antennæ form a close approach to those of *H. io*, as on careful examination with a good lens a second branch of the pectinations of the male antennæ can be perceived; it forms a long separate branch, but is in the dead and dry specimens very closely appressed to the anterior main pectination. In the venation of both wings *Aglia* shows a most unexpected resemblance to *Eacles*

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* Nearly twenty years ago, in 1863, when first beginning my studies on the Bombyces, my attention was attracted to the singular changes of *Aglia tau*, and I compared the young larva to the full-grown larva of *Citheronia regalis*, and pointed out that the latter genus was an "embryonic form, and therefore inferior in rank to the tau moth" ('Amer. Naturalist,' June 1870, and 'Our Common Insects,' p. 52).

† For the sake of clearness, and on account of the differences presented by the larvæ as well as the imagines, I am inclined to provisionally regard this group as of family rank and equivalent to the Ceratocampidæ.

imperialis; like that and other Ceratocampidæ and the Hemileucidæ having five subcostal branches, while in the Saturniidæ there are only four, the first one wanting.

Thus the moth belongs to the Ceratocampidæ, while the larva after the last moult loses all its spines and becomes very much like a Saturnian, perhaps of the type of *Telea*, and especially resembling a smooth form like the larva of *Attacus betes*, Walker, figured by Burmeister in his 'Atlas of the Lepidoptera of the Argentine Republic,' though it is without tubercles or spines. I therefore suggest that *Aglia tau* should be regarded as the type of a distinct subfamily of Ceratocampidæ, and thus the latter group may be divided into the two subfamilies, Ceratocampinæ and Agliinæ.

At present, both from their larval and their imaginal characters and from their spinning a cocoon, I am disposed to consider the Hemileucidæ as a family closely allied to the Ceratocampidæ.

On examining the European genus *Endromis* we are disposed to think that the family Endromidæ is a natural one. It would, however, be a violation of the principle of classification to include *Aglia* with it. The two genera, both as regards their larval and their adult characters, are quite distinct. I find that *Endromis versicolor* has the head, palpi, and antennæ, and the hairy abdomen very closely like those of *Hemileuca maia*; but the median vein of both wings divides into four branches, and the subcostal vein of the fore wings divides into five branches, as in *H. maia* and the other Hemileucidæ. Judging by the coloured figure of the larva in European works the larva of *Endromis* is smooth, with a small retractile head, oblique bars, and a conical caudal horn. The group Endromidæ is a branch of the Bombycian tree parallel to but distinct from the Hemileucidæ, and stands above the latter, connecting this group and the Ceratocampidæ and Saturniidæ with the higher families of the Bombyces in which there are four branches of the median vein, all the families mentioned agreeing with the Notodontidæ in having but three.

In its general shape, the small retractile head, the mode of coloration, and the caudal horn the larva of *Endromis* appears to be remarkably near the Sphinges. Buckley describes the cocoon as " composed of an open-worked reticulation of coarse black or black-brown silk threads, with round or broad oval interstices; the fabric is extremely strong, tough, and elastic, covered externally with moss and birch-leaves; fringe adherent " (iii. 65).

It is interesting that in the transformations of *Rhescynthis* *erythrinæ*, as figured by Burmeister, we have a parallel to the case of *Aglia tau.* The fully grown larva is smooth-bodied and without the four long large thoracic spines and the caudal horns on the eighth and ninth abdominal segments of the previous stage. The genus appears to belong to the Ceratocampidæ.

Although we are not yet acquainted with the early larval stages of *Endromis*, we do not see why the Sphingidæ may not have sprung from a form like this as much as from *Aglia*, as the shape and markings of the full-grown caterpillar are much nearer a typical *Sphinx* than those of *Aglia.* Moreover, taxonomically *Aglia* is by no means so "closely" allied to the Sphingidæ as Mr. Poulton in his able papers would lead us to infer. In its venation *Endromis* is much nearer, and the latter is a more generalized or synthetic form than *Aglia.* From the Ceratocampidæ the families of Saturniidæ and also of Hemileucidæ may have originated, and, indeed, all the Bombyces (unless we except the Arctians and Lithosiidæ) may have evolved before the Sphingidæ appeared. Judging by the characters of the head, the antennæ, thorax, and especially the venation, the Sphingidæ are far removed from the Ceratocampidæ, and their origin from the latter family was at least remote, and there must be some lost, extinct, annectant forms which originally connected them.

XXIV.—*Contributions towards a General History of the Marine Polyzoa*, 1880–91.—*Appendix.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Continued from vol. ix. p. 334.]

'Annals,' February 1882 (p. 82 sep.).

Steganoporella (*Vincularia*) *Neozelanica*, Busk.

In a note on p. 85 (sep.) the last clause of the first paragraph should read thus:—"The latter is a *Membranipora*, the former belongs to a different family." The *Vincularia abyssicola* mentioned in this paragraph is the *Smittipora abyssicola* of Jullien, which he ranks in the family group of the Onychocellidæ *.

The passage relating to the oœcium on the same page has been criticized by Dr. Jullien, who challenges the interpretation which I have given of the upper chamber in the zoœcia

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* Bulletin de la Société Zool. de France, t. vi. (1881).

of *Steganoporella* on the ground that no one has demonstrated the presence of reproductive bodies within it. This may be true, and may be easily explained. All the probabilities point to this interpretation as the true one. The Cheilostomata are generally furnished with external oœcia in which the embryos complete their development. These are wanting in *Steganoporella*, and it is reasonable to suppose that the internal chamber provided by the peculiar structure of the zoœcium may be the equivalent. Amongst the ordinary Cheilostomata species occur which are destitute of oœcia of the ordinary type; their function is discharged by specially modified zoœcia, which are commonly distinguished by the larger size and sometimes the altered shape of the orifice. In the case of *Steganoporella*, as Busk has pointed out*, the upper or oœcial compartment is more developed in some of the zoœcia than in others, and the difference is marked by a difference in the size and pattern of the chitinous framework of the operculum. These structural variations throw light one on the other.

On p. 86 (sep.) a list has been given of the species belonging to the genus *Steganoporella*; but when it was prepared the structure of the group to which this genus belongs had not been thoroughly investigated, and important changes have since been made in the classification. The following table shows these changes:—Genus STEGANOPORELLA: Species *S. magnilabris*, *S. Neozelanica*. Genus THALAMOPORELLA, Hincks: Species *T. Rozieri*, Audouin, and its forms *gothica*, *Indica*, and *falcifera*; *T. Smittii*, Hincks; *T. Jervoisii*, Hincks; *T. steganoporoides*, Goldstein.

Micropora elongata, Hincks, and *M. perforata*, MacGillivray, were wrongly referred to *Steganoporella*. *Vincularia Novæ-Hollandiæ*, Goldstein, which was doubtfully included in *Steganoporella*, is *Thalamoporella Rozieri*, form *indica*, Hincks.

Ibid. (p. 86 sep.).

Monoporella albicans, sp. n.

Ibid. (p. 89 sep.).

Schizoporella aperta, sp. n.

The forms described under the above names agree in general character and in most of the details of structure; but as I was unable to detect an oral sinus in my specimen of the former, it seemed necessary to refer it to *Monoporella*, noting the remarkable similarity in other points between the two forms.

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* 'Challenger' Report, part i. p. 74.

I now believe that in the specimen (or specimens) on which *Monoporella albicans* was founded the sinus was not absent, but was entirely concealed by the suboral umbo, as it is, I find on reexamination, in many of the cells of the other form. *Monoporella albicans* therefore must merge in *Schizoporella aperta.*

'Annals,' August 1882 (p. 96 sep.).

Euthyris obtecta, sp. n.

The larger cells with modified orifice are now known to occur on many species and are no doubt subservient to reproduction. MacGillivray rightly refers *Carbasea* (*Flustra*) *episcopalis* to this genus; but he does not mention whether it possesses the two classes of cell.

'Annals,' March 1883 (p. 104 sep.).

STIRPARIA, Goldstein.

It may be a question, I think, whether this genus can be maintained. The erect segmented stem seems to be the one peculiarity which separates it from *Bicellaria* *, with which it entirely agrees so far as the zoœcial characters are concerned; and the morphology of this structural element has hardly been determined as yet with certainty. There is a close resemblance between the stem of *Stirparia* and that of the genus *Kinetoskias* of Koren and Danielssen, also a Bicellarian form.

Ibid. (p. 108 sep.).

Family **Cellariidæ.**

FARCIMIA, Pourtales.

Farcimia appendiculata, sp. n.

In a paper on "Tertiary Chilostomatous Bryozoa from New Zealand" † Mr. Waters has identified his *Membranipora articulata* ‡ with the present species, and expresses an opinion that if I had "decalcified" my specimens I should have taken the same view. Circumstances have prevented me from

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* Busk refers *Stirparia glabra* (mihi) to the genus *Bicellaria* ('Challenger' Report, part i. p. 35, pl. vi. fig. 1).

† Quart. Journ. Geol. Soc. for February 1887.

‡ "Fossil Chilostomatous Bryozoa from South Australia," Quart. Journ. Geol. Soc., August 1882.

recurring to the subject before; but after a careful reexamination, recently made, I still find myself quite unable to accept his conclusion. *Farcimia appendiculata*, when deprived of all its chitinous appendages and reduced, as far as possible, to the condition of the fossil, differs markedly from *Memb. articulata*, and in my judgment the differences are specific. If we compare the individual zoœcia we can hardly fail to be struck by the points of contrast which they present and which are clearly shown in Mr. Waters's figures and in my own. In the first place there is a remarkable difference in the shape of the cells as well as in much of their detail. That of *M. articulata*, which is inclosed by a conspicuous raised boundary line (the "band" of Waters), is elongate and *hexagonal* in form. The zoœcia are ranged in single file along each face of the quadrilateral stem, and are quite distinct, but are linked together by an extension of the marginal line given off from the summit of each cell. The *aperture* is comparatively small, occupying the upper two thirds of the area, narrow, with straight sides, rounded above and slightly incurved below. A calcareous lamina surrounds the aperture, closing in the space between it and the outer wall.

In *Farcimia appendiculata* the zoœcia are elongate-oval, contracted above, so as to form a framework for the operculum, the extremities in contact or nearly so, the margin rather thin, sloping slightly outward and usually expanded at the base of the cell; the aperture occupying the whole of the area and closed in by a membranous covering; the orifice semicircular, at the very top of the zoœcium. There is some slight diversity in the shape of the cell, the regular oval giving place in many cases to a form which narrows off towards the top and expands considerably below; but in both conditions it is equally removed from that which characterizes the other species. The dissimilarity of the *apertures* in size and shape is very marked and significant, whilst the total absence of the raised boundary-line which surrounds the cells and links them together, and which in *M. articulata* gives its distinctive aspect to the colony, is strong evidence against specific identity. In the presence of such important zoœcial differences I am fully justified in regarding the two forms under consideration as distinct species. I may add that a more searching method of investigation has only made these more apparent.

It is difficult to compare the avicularian appendages in the recent and fossil forms. Those of *F. appendiculata* are remarkable for their size and structure, and almost fill in the space between the lines of cells. Mr. Waters represents in his figure two very small pointed avicularia of the ordinary form near the top of each zoœcium, placed one on each side and pointing downwards. There are no traces of anything more. The appendages of the *Farcimia* are remarkable for their size and are of a peculiar type.

In my previous description of this species I have referred to a structural similarity between its avicularia and those of *Scrupocellaria*; but more accurate observation has convinced me that there are most important differences between them. They consist of an elongate avicularian chamber, tapering slightly downward, convex in front, and adnate to the side of the cell a little below the oral extremity. The top (which is flattened) is occupied by the mandibular apparatus and carried out in front into a small beak-like process; the mandible is rounded. A raised calcareous margin surrounds the chamber (which is also calcareous), and the front is closed in by a chitinous covering. As I have mentioned, the space between the rows of cells is almost entirely occupied by the avicularian appendages.

The differences between *Farcimia appendiculata* and *Memb. articulata* as figured by Mr. Waters, which I have just described, can hardly be due to the changes which have taken place in the fossil. Traces of the large avicularian chamber, which is formed of calcareous material, must have survived, for this structure in the recent form, with the exception of its chitinous envelope, was not materially affected by incineration.

The oœcium in *F. appendiculata* is immersed, as it is in many of the *Flustræ*. In ovicelligerous cells the margin is not carried round the top, its place being taken by the oral arch of the oœcium; the latter occupies a small intercellular space. The oœcium is somewhat shallow, subglobular, the front occupied wholly by a large circular orifice facing the interior of the cell and probably closed by a membrane. Above the operculum of the cell, immediately under the oral arch of the oœcium, is a narrow slit-like opening through which the embryos escape.

In a previous description of this species* I have referred to certain remarkable appendages which are distributed in large numbers over the zoarium. These consist of tall, erect, strap-like bodies, formed of shining membrane of a light brown colour, broad below and for a great part of their length, but tapering off abruptly within a short distance of the tip and terminating in a sharp point. They seem to be always connected in some way with the avicularium—sometimes

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* Ann. & Mag. Nat. Hist. for March 1883.

attached to the side of it, sometimes to the top also, as if to shield it from some danger. But we must have more definite knowledge than we now possess of the function of the avicularia themselves before we are likely to determine the precise office of the subsidiary appendages. It may be noted that the extremity of these curious organs is commonly bent downwards from a definite point.

I do not propose to discuss at any length the generic position of this very interesting form. It possesses characters which, I think, should separate it from *Membranipora*, and may probably be referred to the genus *Farcimia* of Pourtales*, of which Smitt, in his 'Floridan Bryozoa' (part ii. p. 3), has given an interesting account, pointing out its distinctive peculiarities. The generic name, as he has remarked, was originally given by Fleming to a *Cellaria*, and is therefore a mere synonym available for further use.

Ibid. p. 109 (sep.).

Schizoporella cinctipora, sp. n.

Mr. Waters has described and figured a variety (*personata*) of this species † from New Zealand Tertiary beds. The differences, however, between the supposed varietal form and the recent *S. cinctipora* as figured seem to be so striking and important that I venture to question their specific identity.

Ibid. (p. 109 sep.).

Lepralia foraminigera, sp. n.

This species has also occurred in the New Zealand Tertiaries. Mr. Waters notes that only the two upper openings in the cell-wall occur in fossil specimens.

Ibid. (p. 110 sep.).

Lepralia rectilineata, sp. n.

This has also been found fossil in New Zealand. Waters mentions that there is "often a small ridge or boss at each side of the aperture, just below which there are two small avicularia." The oœcium, which I had not met with, is described as "raised, globular, about half as wide as a zoœcium."

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* Bull. Mus. Comp. Zool. Harvard Coll. Cambridge, no. 6, p. 110.

† Quart. Journ. Geol. Soc., Feb. 1887.

Ibid. (p. 110 sep.).

Mucronella bicuspis, sp. n.

This species is ranked by Waters as a variety of his *Smittia biincisa*[*]. I have not had the opportunity of examining specimens of the fossil form, which was procured from Tertiary deposits in South Australia and New Zealand; but, judging from the figure, I can hardly think that there is sufficient ground for identifying it with *M. bicuspis*. The general character of the orifice seems to me to be very different in the two; the lateral avicularia, a very constant feature of the recent species, are wanting in the fossil, while the tubular avicularia which are so conspicuous a characteristic in the fossil are wanting in *M. bicuspis*. The oral denticle of the latter is peculiar; but Mr. Waters has noticed some variability in this portion of the structure.

The difference between the characters of the cell-wall in the two forms is remarkable. Not only are there *more* of the large pores in *S. biincisa*, but they differ in shape and arrangement from those of the recent species. They form a reticulate covering over the whole surface of the cell, whilst in *M. bicuspis* they are disposed in a single line running across the front of the cell. At the same time it must be admitted that the superficial character of the cell-wall is liable to much variation. Mr. Waters's experience as a student of fossil Polyzoa entitles his judgment to much respect in a case of this kind, and on the whole I prefer to leave the question an open one.

'Annals,' May 1884 (p. 358)[†].

Membranipora marginella, sp. n.

Two of the four cells figured bear oœcia; the cells mentioned in the description as furnished with a large dark-coloured operculum, "occupying nearly half the area," are probably avicularian.

Ibid. (p. 358).

Smittipora abyssicola, Smitt.

The genus *Smittipora* is, in my judgment, a synonym of *Onychocella*, Jullien, the differences between the two being quite immaterial.

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[*] Quart. Journ. Geol. Soc., August 1882, p. 272; *ibid.* February 1887, p. 58.

[†] From this point to the close of the "Appendix" the paging is that of the 'Annals' and not of the separate copies.

Ibid. (p. 360).

Microporella Fuegensis, Busk (sp.).

This is not a *Microporella*, as it wants the suboral pore characteristic of this genus. It is furnished with the peristomial pore, which is a leading character of Busk's *Adeonella*; but this has a totally different structural significance.

As there is considerable doubt about the latter genus, I shall postpone the discussion of the systematic place of the present form.

[To be continued.]

XXV.—*A Reply to some Observations on the Mouth-organs of the Diptera.* By B. Thompson Lowne, F.L.S.

Mr. Charles O. Waterhouse in the January number of this Journal appears to invite me to reply to what, for want of a better term, I may designate a "quip courteous," in which he has availed himself of the saving qualities of an "if."

My critic has, curiously enough, seen more in my book than I ever wrote or intended, and has failed to see what I did write; therefore I avail myself of an "if."

If Mr. Waterhouse had used no more acumen in the interpretation of the mouth-parts of the Diptera than he has brought to bear on the interpretation of what I have said I should not have been surprised that he still holds the old and time-honoured opinions regarding the mandible of the dipterous mouth. I do not, however, for a moment suppose that he reads "Nature" as carelessly as he reads my work; but I think he might have rewarded the "skill and care" which he credits me with by a little more attention before he consigned me to oblivion in the pit of error in some unknown region; for if I have fallen into "some error," the nature of which is not even indicated, my position is no better, and there is small chance that a passing friend may draw me out. Therefore it behoves me to make an effort to save myself.

The main argument I use in favour of the views I have adopted is the manner in which the parts in question are developed. If I have falsely interpreted the appearances relating to their development I am as likely to be wrong as another; therefore the question at issue is: Are the mouth-parts of *Musca* developed as Mr. Lowne states or are they not? There are no side issues to the question.

Now with regard to my sins of omission. Mr. Waterhouse is doubtful as to what I mean by parts of the maxilla; yet on page 154 of my book I have indicated that I regard the lancets as homologous with the palpiger and the lacina respectively.

My critic then makes it appear that "I blow hot and cold" according to my necessities. It is true I said that the position of the pseudo-labium is no evidence from a morphological point of view. In this Mr. Waterhouse concurs. But I have nowhere stated that position is never of value in establishing the morphology of a part.

It is possible that two pairs of appendages are fused in the dipterous proboscis; it is conceivable that three are so united, and it is further possible that these limbs are so entangled and crossed, that position would afford no evidence of the morphology of their distal extremities. Moreover the mere similarity of a terminal joint to that of an homologous appendage, such as Mr. Waterhouse appeals to, is not evidence that this joint belongs to a mandible or a maxilla. The hoofs of a horse's feet are similar; but it would be hazardous to conclude that a limb with two hoofs consists of a fore and hind limb united. I see no reason at all why the terminal joint of one of the divisions of the maxilla should not resemble a mandible when it has similar functions to perform.

As regards the simple eye of the flea the case is very different. Its relation to the antenna is such that it cannot be explained on the supposition that the sternal plates of the cephalic segments are dorsal, as the position of the antennæ is explained in *Truxalis* and *Fulgora*. Moreover Mr. Waterhouse supposes an imaginary case, which does not exist so far as we know. It will, I think, be time to consider its bearings on the view I have adopted after its discovery. In the meantime I assume that it does not happen that the compound eye ever bears the relation to the antennæ which the simple eye of the flea exhibits.

Mr. Waterhouse credits me with a consistency which I do not deserve. When I published my book on the Blow-fly in 1870 I never said of the proboscis that "it is mainly formed from the maxillæ." I then regarded it as a complex of several metameres. I was wrong; but until I discovered the manner in which it is developed no one had done so. The contradictory statements of various writers on the subject will themselves speak for the difficulty which exists in making the parts of the proboscis conform to the received theory; and the very fact that some have regarded it as composed of several metameres whilst others deny it metameral characters shows that the theory does not fit with the facts.

Mr. Waterhouse is unfortunate in having ascribed a preconceived opinion to me, as my early writings show that I formerly held very different views—views which I have since given up; and I first published the idea that the proboscis is developed mainly from the maxillæ in a short paper in the 'Quekett Club Journal' of 1887.

Although when my present work was first contemplated I was asked to bring out a second edition of my former book, I soon found that it would be entirely new, and Mr. Waterhouse has committed a slight inaccuracy in speaking of my present book as a second edition of one published in 1870. I should have thought that the mere fact of its containing four times the matter already, and a prospect of its containing 700 pages when complete, might have indicated this; moreover it has a different title. But perhaps it is too much to expect in these days of high pressure that those who quote a work should look at the title.

XXVI.—*Description of a new Species of* Sminthus *from Kashmir.* By Oldfield Thomas.

THE remarkable genus *Sminthus*, which, *nota bene*, is a member of the Dipodidæ [*], not of the Muridæ, has been until recently considered to consist of only a single species, *S. subtilis*, Pall. (*S. vagus*, auct. plurim.), ranging from Denmark to Central Asia. Quite recently Dr. Büchner [†] has described a second species, *S. concolor*, from Ganssu, China, a species which has not the characteristic black dorsal stripe of *S. subtilis*; and I have now the opportunity of describing a third one of the same most interesting group.

The type specimen is a skin with skull, obtained in Kashmir, at an altitude of 10,000 feet, by Major G. H. Leathem, of the East Surrey Regiment, in whose honour I propose to name the species

Sminthus Leathemi, sp. n.

Extremely similar in size, colour, and general appearance to *Mus sylvaticus*, from a British specimen of which it is at first sight hardly distinguishable, except that the ears are decidedly smaller.

[*] This view of the true affinities of *Sminthus*, first published by Winge in 1887 ('Gnavere fra Lagoa Santa—E Museo Lundii,' p. 109), had been held by me long previously, and I still think it is unquestionably correct.

[†] Bull. Ac. Sci. St. Pétersb. xiii. p. 267 (1892).

Fur long and soft. General colour rufous grey, becoming clearer rufous on sides; no trace of a darker dorsal stripe. Belly white from chin to anus, but the hairs slate-coloured for their basal three fourths. Ears short, rounded, their visible parts when folded (*i. e.* the posterior two thirds of their inner and the anterior third of their outer surfaces) thickly clothed with short chocolate-brown hairs. Arms and legs whitish; hands and feet silvery white on their upper surfaces; palms and soles naked; hallux reaching to the base of the second toe, fifth toe to the middle of the second joint of the fourth. Tail elongated, conspicuously bicolor, brown above, both hairs and scales, white below.

Skull decidedly larger than that of *S. subtilis*, narrower and more elongated anteriorly, and with a longer and more oval brain-case; interparietal bone decidedly broader than that of *S. subtilis*, its antero-posterior only about a third of its transverse diameter. Anterior palatine foramina shorter, extending backwards only to the level of the middle of the premolar; palate posteriorly ending close behind the posterior molars, while in the allied species it is continued backwards for a distance equal to the combined lengths of $\underline{\text{p. 4}}$ and $\underline{\text{m. 1}}$.

Teeth apparently quite as in *S. subtilis*, except that $\underline{\text{m. 3}}$ is longer, as long as broad, instead of being transversely oval; $\overline{\text{m. 3}}$ is also correspondingly slightly longer in proportion to the other teeth.

Dimensions of the type (a male):—

Head and body (measured in the flesh by Major Leathem) 66 millim.; tail (ditto) 112; hind foot (from skin) 19; ear (from skin, approximate) 8·3.

Skull: greatest length (occiput to nasal tip) 20·7; nasals, length 7·7, greatest breadth 2·7; interorbital breadth 4·2; greatest breadth across brain-case 9·6; interparietal, length 2·3, breadth 7·0; palate, length 8·2; diastema 5·0; length of palatine foramina 4·0; length of upper tooth-series 3·1.

Hab. Krishnye Valley, Wardwan, Kashmir. Altitude 10,000 feet. Type obtained June 24, 1892.

As may be seen from the above description, this new species is widely removed from *S. subtilis* and approaches in many characters the Chinese *S. concolor*. From this it is distinguished externally by its conspicuously bicolor tail, by its brighter coloration, and shorter ears. In the skull it agrees closely with the same animal as regards the general measurements and in the "stärker verschmälert und schlanker ausgezogen vordere Partie" (both being compared with *S. subtilis*); but it is impossible to believe that so careful an observer as

Dr. Büchner could have overlooked the marked differences in the palate and interparietal had they also been present in his species; so that I suppose *S. concolor* agrees with *S. subtilis* in these respects.

As to the structure of the teeth, all the members of the genus seem to have the small fifth cusp on $\frac{\text{m. 1}}{}$, which is stated by Dr. Büchner not to be present in *S. subtilis*; for in three specimens of that species in the Museum, from widely different localities, I find it clearly visible, although smaller than in *S. Leathemi.* I presume, therefore, that Dr. Büchner had under examination only specimens with worn dentition.

Major Leathem is to be congratulated on his discovery of this interesting little animal, the first representative of its genus found within British Indian territory.

XXVII.—*Further Notes on the Genus* Chiroderma.

By Oldfield Thomas.

The following points with regard to the Chiropterous genus *Chiroderma* have arisen out of the publication of Dr. H. Winge's 'Bats of Lagoa Santa'[*] and of Dr. H. Allen's remarks on the genus in connexion with the description of his *Vampyrops zarhinus*[†].

In the first place, my own remarks on the genus itself seem to have been unaccountably misunderstood by the latter author, for, far from "claiming that *Chiroderma* is not distinct from *Vampyrops*," I maintained, in the paper criticized by him[‡], that it was a perfectly distinct genus, and gave it a place in the synopsis of genera on p. 170, although at the same time two species referred by Dr. Dobson to *Chiroderma* were transferred to *Vampyrops*. Nor do I by any means "acknowledge that the nasal cleft disappears in old individuals," as Peters's statement to this effect was not accepted in my paper and was explained away in the last paragraph of p. 169.

One mistake in my paper, however, I should like to correct more prominently than I have hitherto done, namely as to the spelling of the new species there described. This should be *Vampyrops Caraccioli*, instead of *V. Caracciolæ*, the mistake having been due to a misconception as to the name of the discoverer, Mr. Caracciolo, whose proper name is now well

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[*] 'Jordfundne og nulevende Flagermus fra Lagoa Santa, Minas Geraes —E Mus. Lundii,' 1892.

[†] Proc. Ac. Philad. 1891, p. 400.

[‡] Ann. & Mag. Nat. Hist. (6) iv. p. 167 (1889).

known to zoologists in connexion with the foundation of the Trinidad Field Naturalists' Club, of which he is president.

Again, in 1891 I had the opportunity of describing* a Stenodermatous bat, this time of the genus *Chiroderma* itself. That description was based on the Minas Geraes specimen called in Dobson's Catalogue *Chiroderma villosum*, Peters; and reasons were shown why it should be looked upon as distinct, and the name *Ch. Doriæ* was given to it. In the contrasted descriptions of the teeth of the two forms on p. 882 two important misprints have crept in, which, although they might be detected on a careful reading of the whole paper, yet, placed in so prominent a position, might easily deceive any one working on the subject. The mistake consists of the transposition of the dimensions of the posterior teeth of *Ch. Doriæ* and *Ch. villosum*, so that each is made out to have the dimensions of the other. The erroneous lines should therefore read:—

	Ch. Doriæ.	*Ch. villosum.*
Posterior upper premolar and two molars	Larger, combined length 7·4 mm.	Smaller, combined length 6·0 mm.
Posterior lower premolar and two molars	Combined length 8·2 mm.	Combined length 6·3 mm.

Thanks to the kindness of Dr. H. Winge, the National Collection has now obtained from the Copenhagen Museum a number of the specimens from Lagoa Santa described by him in the valuable paper quoted above. Among these there is a specimen called by him *Chiroderma villosum*, apparently in ignorance of my paper, for on examination this proves, as might be expected from its locality, to be an example of *Ch. Doriæ*, agreeing in every respect with the type, except that its outer incisors are rather shorter, perhaps owing to greater wear. This very species, according to Dr. Winge, was the one termed by Lund "*Phyllostoma dorsale*," but without description; so that my own much later name will still have to stand for it.

The full synonymy of the Minas Geraes species will therefore be:—

Chiroderma Doriæ.

Phyllostoma dorsale, Lund, Blik Bras. Dyrev., Dansk. Afh. ix. p. 200 (1842) (nom. nudum).

Chiroderma villosum, Dobs. Cat. Chir. B. M. p. 534, pl. xxix. fig. 2 (dentition) (1878); Winge, E Mus. Lundii, 1892, p. 9, pl. i. fig. 12 (skull and teeth) (nec Peters).

Chiroderma Doriæ, Thos. Ann. Mus. Genov. (2) x. p. 881 (1891).

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* Ann. Mus. Genov. (2) x. p. 881.

XXVIII.—*On the Development of the Germinal Streak of* Mysis. By R. S. Bergh, of Copenhagen *.

My investigations commence approximately at the stage at which the segmentation has concluded and the formation of the germinal layers begins. On the termination of the process of segmentation the blastoderm has extended round the yolk in every direction, and there now arises a thickening of the blastoderm in the form of a transverse streak (this streak occupies a transverse position with reference both to the longitudinal axis of the ovum as also to the subsequent longitudinal axis of the embryo). In this thickened streak the cells are at first arranged in only a single layer, and the thickening is consequently occasioned merely by the greater height of the cells of this region. Soon, however, the streak becomes bilaminate at a certain spot in the neighbourhood of the median line, since some few cells push their way inwards and shortly afterwards undergo active multiplication within the outer layer. I have observed stages in which only two, four, or six inner cells are present, but the number soon becomes much larger; figures of nuclear division are frequently met with. The inner mass of cells which has thus been formed now speedily separates into three different rudiments:—(1) certain cells wander about and develop into *vitellophaga* ("Vitellophagen"); (2) other cells (which adjoin the median line) become more firmly united together into a plate and constitute the true (intestinal) endoderm; (3) towards the sides certain others develop as *primitive cells of the muscle-plates* (mesoderm of authors). The final number of these primitive cells is four on each side, though in earlier stages not so many of these larger lateral cells are to be seen. As soon as the definitive number is reached these cells commence to produce smaller ones in front by the process of budding ("Knospung"); thus four longitudinal rows of cells are formed on each side within the ectoderm, so that in certain stages any transverse section from the region in question contains four muscle-plate cells on either side. With further growth the muscle-plates become very distinctly segmented, and I see no reason to doubt that their divisions correspond to actual proto-segments. The latter soon become separated from one another, since the growth of the muscle-plates does

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* Translated from the 'Zoologischer Anzeiger,' xv. Jahrg., no. 406, November 28, 1892, pp. 436–440.

not keep pace with that of the ectoderm, so that the divisions of the germinal streak which contain proto-segments alternate with others in which no elements of the muscle-plates are to be found: by this means this "primitive segmentation" can be recognized with peculiar distinctness. Each proto-segment at first consists of a simple transverse row of cells: it is not until later on that these multiply, so that the rudiment gradually comes to consist of several rows and several layers, when, owing to the fact that the proto-segments then fuse together, the muscle-plates develop into a continuous layer within the ectoderm.

The ingrowth alluded to above, through which the deeper cell-layers of the embryo are formed, without doubt corresponds to the gastrula-invagination, from the lateral margins of which the formation of the muscle-plates consequently proceeds in this case also. Whether these muscle-plates belong genetically to the ectoderm or to the endoderm it was impossible to decide, and the question is one of those which in many cases are most difficult of all to determine, but nevertheless are often "decided" with the utmost arbitrariness. The blastopore has no relation whatever either to the mouth or anus; its situation is in the neighbourhood of the future anus: this, however, does not arise until much later, long after the blastopore has become completely unrecognizable. Before the formation of the gastrula-ingrowth no yolk-cells are to be found.

At the anterior margin of the blastopore a very peculiar differentiation of certain ectoderm-cells takes place: these develop into *primitive cells of the ectodermal portion of the germinal streak.* The definitive number of these cells is *seventeen* or *nineteen* (I find sometimes the one, sometimes the other); they form a transverse arcuate streak in front of the blastopore. The first stages of the differentiation and grouping of these cells seem to last only a very short time; for, in spite of the fact that I examined a very large number of germinal disks at such stages, I am only able to assert that I have found stages with nine, eleven, thirteen, and fifteen primitive cells; less than nine primitive cells were not found, and consequently no transition between this stage and the earlier phase, at which such a grouping of the cells is altogether indistinguishable; it was likewise impossible to determine whether the original nine cells multiply into the seventeen or nineteen by means of fission or whether their number is augmented by accessions from other neighbouring cells.

So soon, however, as the definitive number* is attained, these cells commence precisely the same process as the primitive cells of the muscle-plates (the cells lying nearest to the median line are the first to begin, and are followed by those occupying a more lateral position): they produce smaller cells in front by budding ("Knospung"). In this manner there consequently arises *an ectodermal germinal streak, formed of seventeen or nineteen longitudinal rows of cells.* The cells of this germinal streak are also seen to be arranged very regularly in transverse rows, and the cell-divisions take place precisely in the same manner and with the same regularity as I recently described in the case of *Gammarus.* A median row of cells is always found, which is derived from a median primitive cell; therefore the number of the primitive cells and of the rows of cells is always an uneven one.

This ectodermal primitive streak extends in front as far as a line which connects the points of insertion of the right and left mandible. In front of this line we find in all stages under consideration a mosaic of ordinary polygonal ectoderm-cells, which are not arranged in rows and are not derived from the above-mentioned primitive cells. It seems to me that this fact, that *the ventral ectoderm is differentiated, so to speak, into a nauplial and* (sit venia verbo) *metanauplial rudiment*, is not entirely devoid of interest. The *Nauplius* appendages grow out from the anterior mosaic of cells; but the whole of the appendages which are situated behind the mandibles owe their origin to the germinal streak which is derived from the primitive cells. Behind the primitive cells there is formed at an early period an embryonic (provisional) forked caudal fin ("Schwanzflosse"), which is very distinct in the *Nauplius* stage. The epidermis withdraws by degrees from the chitinous covering of this caudal fin, and the definitive caudal fin is formed considerably further forward from the material of the germinal streak. It is probable that the only other structure which arises from the cell-material lying behind the primitive cells is the telson, though this is difficult to prove.

The position of the endoderm-plate in different stages is worthy of notice. Situated at first behind the ectodermal primitive cells, it travels by degrees on the inside of these and of the germinal streak very far forwards, until it enters the region of the mandibles. The primitive cells of the muscle-

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* The numerical theorists of Prague are here furnished with interesting subjects for study. A comparison of the conditions of *Mysis* and *Gammarus* with reference to the validity of their laws would certainly have a brilliant result.

plates, too, lie at first close behind, but in later stages close in front of the ectodermal primitive cells. At last all the primitive cells split up into smaller cells.

When the organs (nervous system and appendages) begin to develop from the germinal streak the regular arrangement of the cells in rows gradually disappears, since they commence to divide in different planes. I am entirely unable to state positively how many of the original longitudinal rows enter into the formation of the ventral nerve-chain; it seems to me most probable that it is only the median row and the one lying next to it on each side which take part therein. Another process, however, is very distinctly recognizable in the formation of the ventral chain; for the ectoderm-cells which are destined for the production of the ganglion-cells become developed as primitive cells, which, by means of budding, give rise to rows of smaller cells towards the interior in a manner precisely similar to that which Wheeler[*] has described in the case of Insects. Yet in *Mysis* the "neuroblasts" (as Wheeler terms them) are not covered by the epidermis, but actually represent the most superficial layer of cells of the region in question, and, so far as I am able to observe, persist throughout as epidermis-cells, while in the case described by Wheeler they are situated within the epidermis.

A torsion of the germinal streak, such as I recently described as occurring in *Gammarus*[†], does not take place in *Mysis*.

As is evident from what has been stated above, besides many points showing great agreement with the conditions which are found in *Gammarus*, several noticeable deviations from what is seen in the last-named form also occur. In this connexion the existence of the larger primitive cells at the posterior end of the germinal streak of *Mysis* is especially worthy of mention, since these are wanting in *Gammarus*. On the whole *Mysis* is a more convenient and more easily manipulated object for the study of the processes which are here alluded to. The above results were derived partly from the study of series of sections, but chiefly from the examination of transparent surface-preparations. J. Nusbaum[‡], the most recent monographer of the development of *Mysis*, has

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[*] Wheeler, "Neuroblasts in the Arthropod Embryo," Journal of Morphology, vol. iv., 1891, p. 337 *et seq.*

[†] Zool. Anzeiger, 1892, no. 396.

[‡] J. Nusbaum, "L'embryologie de *Mysis chamæleo* (Thompson)," Arch. de Zool. exp. et gén., sér. 2, t. v., 1887, p. 123 *et seq.*

entirely neglected the study of surface-preparations of this kind, and consequently the conditions which are here described were almost completely ignored by him. In the present brief communication I am unable to make further reference to the literature of the subject.

BIBLIOGRAPHICAL NOTICES.

A Catalogue of British Jurassic Gasteropoda. By W. H. Hudleston, M.A., F.R.S., P.G.S., and Edward Wilson, F.G.S. 8vo. Pp. xxxiii and 147. Dulau and Co.: London, 1892 (November).

The very aspect of the pages of this book reminds a working Geologist of the well-known 'Morris's Catalogue of British Fossils,' even without the allusion in the Preface to the latter still useful book, though it has long been out of print. This new Catalogue, however, is limited (as its Title intimates) to one Molluscan group of one Formation, and has very good additional features in its lists of localities, bibliographic catalogues, table of genera, notes on some genera and on doubtful and rejected species. Moreover, the synonymy and references are far more liberally represented than in the former work.

The plan of this Catalogue is clearly laid down in the "Explanatory Note," pp. xi–xvi; and the palæontological bearings both of the whole group and of its divisions are treated of in the Preface, pp. v–x.

The long experience and the accurate knowledge of the two energetic Authors may be well trusted for the satisfactory fulfilment of the task they have undertaken and brought to publication in this work; and their nomenclatorial and general literary style and method are decidedly good. Great pains have evidently been taken to have quite correct printing; and severe judgment has evidently been exercised in coming to a conclusion in cases of doubtful priority, in choosing the best and most necessary references, and in determining the synonymy.

Sixty-five genera and subgenera of British Jurassic Gasteropoda, with their frequently numerous species (122 in *Cerithium* and 78 in *Pleurotomaria*, for instance), constitute the chief material here reduced to zoological order, as far as the often imperfect preservation of the shells permits. The six genera from the Rhætic Beds are similarly treated (pp. 137–139).

Thus all the evidences that the relics of Gasteropods in the British and, in many associated instances, foreign Jurassic strata can yield to the experience of experts, as to zoological and geological conditions and changements, are here brought to our convenient notice in a well-printed Catalogue. This is worthy of the attention and well fitted to the use of geologists, whether working earnestly in the details of the science or taking up the pleasures of "collecting" at a given locality or in a given formation.

The abundant fruits of research among the British Jurassic Gasteropoda during the last forty years, largely due to the energy and acumen of W. H. Hudleston, and incorporated in this work, thus occupy 120 pages in the new Catalogue, whilst 55 pages of 'Morris's Catalogue' served for all the known fossil Gasteropoda of Britain; the very limited and condensed references, however, in the latter somewhat affect the comparison.

It is to be hoped that the scientific public will liberally support the publication of such excellent catalogues of the British Fossils as the book under notice and Woodward and Sherborn's 'Catalogue of British Vertebrates,' brought out by the same publisher, and reviewed in the Ann. & Mag. Nat. Hist. ser. 6, vol. v., 1890, pp. 337 &c. Such trustworthy exegetical catalogues of fossils as these are much wanted. They clear the way for students and others; they do much for the avoidance of error; and they save loss of time and patience in looking for the history of known species and for the probable relationships of newly-found fossils.

The Jurassic Rocks of the Neighbourhood of Cambridge. By the late Thomas Roberts, M.A., F.G.S. 8vo. Pp. vii and 96. C. J. Clay and Sons. London, 1892.

This memoir was the "Sedgwick Prize Essay" for 1886. The Author, who had collected and discussed so many useful points in the distribution and natural history of these Jurassic strata, unfortunately died, at an early age, whilst adding new facts and perfecting the views which he had advanced with care and perspicuity. Lamenting his death and desirous that his good work should not be lost sight of, some of his colleagues in the Woodwardian Museum and other friends have put together the notes that he left and have brought out this Prize Essay, so enriched, as a lasting memorial of a geologist whom his many friends highly respected and wish to honour.

The Oolites of Cambridgeshire and northwards differ from those of the south in several particulars, on account of the two series having been laid down on and against a ridge or ridges of Palæozoic rocks, making shoals in the sea of the Jurassic period, and trending north-easterly and then northerly. Hence not only does the strike of the Oolitic strata vary in the East-Anglian district, but their constituent deposits vary in character, both according to the local depths of the sea and the kinds of material supplied by the organic remains, and by the sediments brought from the shores. Thus "throughout the greater part of the period the deposits were laid down under locally shifting geographical conditions, so that the district was from time to time divided into different and changing hydrographical areas, the sediments varying as barriers disappeared or were introduced, and the forms of life more or less readily yielding to the influence of external circumstances."

Moreover the higher members of the Oolitic group, seen in the south-west, are wanting in East Anglia, either not having reached so far as deposits along the old sea-bottom or having been removed by denudation.

Particular points in the inquiry carried out by Mr. Roberts were as to the exact geological value of the several bands in the Kimeridge and Oxford Clays, and as to strata representing the Corallian series of neighbouring districts. Here the careful collection and exact determination of the fossils were most important; and chiefly by means thereof the author came to the conclusion that the Oolites of the district under consideration might be tabulated as follows:—

1. Kimeridge Clay $\left\{\begin{array}{l}\text{Upper.}\\ \text{Lower.}\end{array}\right.$
2. Amptill Clay $\left\{\begin{array}{l}\text{Upware Section.}\\ \text{Coral-rag.}\\ \text{Coralline Oolite.}\end{array}\right.$
3. Lower Calcareous Grit. (The Elsworth and St.-Ives Rocks.)
4. Oxford Clay.

This last great formation is here represented by three palæontological zones:—

1. Zone of *Ammonites perarmatus* (rare), *A. crenatus*, *A. oculatus*, and the *Cordati* group of Ammonites of the St.-Ives clay-pit.
2. Zone of *Waldheimia impressa*, at the base of the St.-Ives clay-pit.
3. Zone of *Ammonites Duncani* and *A. Jason* (the *Ornati* group of Ammonites) of St. Neots. [Lowest zone.]

The valuable, because trustworthy, lists of fossils from the several bands of clay and stone and the full stratigraphical description of other strata,—the careful references to foregoing observations and descriptions,—and the correlation of the Oolites of Cambridgeshire with those of other English districts (pp. 77–86) and with foreign equivalents (pp. 87–94), render this Memoir of very great value to all concerned with the physical geography, the geology, and the palæontology of this classic ground and of the corresponding regions in France and Germany.

The Tertiary Fauna of Markuševec in Croatia. [*Fauna fossile Terziaria &c.*] By S. Brusina. 8vo. 98 pp. Zagreb (Agram). 1892. [Reprint from the 'Glasnika Hevats. Naravosl. Druztva,' vii. Godina.]

This memoir, published by the Natural-History Society of Croatia, is a continuation of the results of the researches of Spiridion Brusina on the palæontology of Dalmatia, Croatia, and Slavonia, more especially the Tertiary Mollusks (largely of estuarine or brackish character). The Director of the National Museum has devoted much time and energy to this work, some results of which were noticed in the Ann. & Mag. Nat. Hist. for June 1875; and other results have been since published in Austria-Hungary.

Some fossils collected by him from a sandstone of the "Congerian Formation" at the "Kelekovo polje," not far from Markuševec, were found to comprise some vertebræ, teeth, and otoliths of fishes, fragments of Polyzoa, numerous valves of Ostracods, tubes of Annelides, spines of Echinoderms, spicules of Sponges, and many Foraminifera. This collection is so important to local and other geologists that a full list is given of its species of *Limax*, *Helix*, and *Succinea* (few), 2 of *Limnæa*, 8 of *Planorbis*, 1 of *Melania*, 17 and more of *Melanopsis*, 2 of *Melanoptychia*, 26 and more of the Hydrobiidæ, 7 of Valvatidæ, of *Orygoceras* 4, *Cyclostoma* 1, *Neritona* 1, *Neritodonta* 6, *Congeria* 7, *Limnocardium* 5, *Pisidium* 1. Of these several are new species, most of which are described in this memoir, and some are species not yet determined sufficiently to be named.

This group of fossil mollusks is carefully compared in detail with those of other localities in Eastern Europe and with the fauna of the Caspian and of Lake Baikal; and the Author acknowledges his indebtedness for help and cooperation to his several friends and fellow-workers.

Mollusks from the "Sarmatian Formation" at Markuševec are enumerated at pages 80–82; and an Appendix gives a list (with localities) of the fossil Dreissensidæ of Dalmatia, Croatia, and Slavonia, namely 20 species of *Congeria* and 7 of *Dreissensia*.

An Index of the fossil species contained in Parts I. and III. of S. Brusina's work then follows, pp. 89–96, and of the special recent representatives at pp. 97 and 98.

MISCELLANEOUS.

On a Sporozoon parasitic in the Muscles of the Crayfish.

By MM. F. Henneguy and P. Thélohan.

We have recently* reported the existence of a Sporozoon living as a parasite in the muscles of *Crangon vulgaris* and very closely

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* Henneguy and Thélohan, "Sur un Sporozoaire parasite des muscles

allied to that which one of us * had already described as occurring in *Palæmon serratus* and *P. rectirostris.*

We have since had occasion to observe in the muscles of the Crayfish a parasite which likewise belongs to the group of the Sporozoa, but which exhibits somewhat remarkable differences from the foregoing forms.

Thanks to the kindness of M. Contejean we have been able to examine fragments of Crayfish muscles from the Department of the Doubs, which in the fresh state exhibited that remarkable opacity to which we have already drawn attention in *Crangon* and *Palæmon.*

In sections of these muscles we have found that the fibres are attacked by a parasite in different stages of development.

At certain points the muscle-fibre is found to be crammed with little ovoid spores having a clear vacuole at their large extremity. The appearance of these spores reminds us of those of the Microsporidia, of *Glugea*, and of the parasites of *Crangon* and *Palæmon.* They are much smaller than the spores in *Crangon* and in size approach those in *Palæmon.*

By the side of these spores younger stages of the parasite are found, represented by nucleated masses of protoplasm. Our observations, though they are as yet very incomplete, have nevertheless enabled us to determine that this organism differs from the parasite of the *Crangon* and of the two species of *Palæmon* in the mode of the development of the spores. These, instead of being formed in a group of eight in each sporogenous vesicle, are produced in variable but always larger numbers. In this character the parasite of the Crayfish approaches the Microsporidia and certain forms of the Myxosporidia.

As regards the group to which this parasite ought to be assigned, since we have not had fresh material at our disposal we have not been able to study the structure of the spores sufficiently thoroughly in order to pronounce an opinion upon the point.

The presence of this sporozoon in the muscles of the Crayfish offers a double feature of interest: it causes our first observations to extend to a larger number of species of Crustacea, and, moreover, it seems that it ought to be of a certain practical importance from the point of view of the etiology of the disease which for several years past has destroyed the Crayfish of our watercourses in the east.—*Comptes rendus des Séances de la Société de Biologie* (Séance du 30 juillet, 1892): from a separate impression communicated by the Authors.

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des crustacés décapodes," Comptes rendus de la Société de Biologie, June 25, 1892 (Ann. & Mag. Nat. Hist. ser. 6, vol. x. pp. 342–344).

* Henneguy, "Note sur un parasite des muscles du *Palæmon rectirostris*," Mémoires publiés par la Société philomathique à l'occasion du centenaire de sa fondation (1888).

THE ANNALS

AND

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No. 63. MARCH 1893.

XXIX.—*The Affinities and Origin of the Tardigrada.*

By Prof. J. von KENNEL *.

LIKE the majority of the so-called aberrant groups in the Animal Kingdom the Tardigrada have met with the most diversified experiences in systems of classification. At one time they were ranked among the "Worms," at another among the Arthropods, and they have been assigned at different periods both to Crustacea and Tracheata. They were treated as an "appendage" to these groups or else as "ancestors" of them, and were regarded as degenerate or greatly reduced or as highly primitive forms. A comparison of the various views upon this question has been furnished by Plate †, who also discusses in a subsequent paper ‡ a theory by Bütschli § which had previously escaped his notice.

Now I am in entire agreement with Plate's view that the Tardigrada can be brought into relationship only with the tracheate Arthropods, and do not consider it necessary to support or amplify the arguments which he advances against

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* Translated from the 'Sitzungsberichte der Naturforscher-Gesellschaft bei der Universität Dorpat,' ix. Bd. Heft iii. (Dorpat, 1892), pp. 504–512.

† Plate, "Zur Naturgeschichte der Tardigraden," Zool. Jahrb. Bd. iii.

‡ Plate, "Die Rotatorienfauna des bottnischen Meerbusens &c.," Zeitschr. f. wiss. Zool. Bd. xlix.

§ O. Bütschli, "Untersuchungen über freilebende Nematoden und die Gattung *Chætonotus*," Zeitschr. f. wiss. Zool. Bd. xxvi.

their being allied to the Crustacea. Notwithstanding this, however, with regard to the systematic position of these animals I have arrived at quite a different conclusion, which more nearly resembles the older ideas, and regards the Tardigrada as degenerate forms of higher Tracheates. Plate declares that "the Bear-animalcules are the lowest of all the air-breathing Arthropods with which we are at present acquainted, and must be placed at the bottom of the Tracheata, even below the Onychophora." Nevertheless, as may well be imagined, he does not derive *Peripatus* from them, but states that "they form an offshoot of the great Tracheate stem, which, however, lies much nearer the root of the latter than any other branch of that stock. They are the group in which the transition from the Annelids to the air-breathing Arthropods is most clearly expressed and most distinctly recognizable."

To this opinion I am unable to assent. In the species of *Peripatus* we have animals which furnish the best transition between Annelids and Tracheates, and I have elsewhere * explained at length the reasons why it is probable that forms resembling *Peripatus* were the ancestors of the Myriapod-like Tracheata, from which again the rest of the Tracheata are descended. The bodily form, the organs of locomotion, the commencing formation of head and jaws, the nervous system, the eyes, the sexual organs, and the tracheæ of this group of animals may without difficulty be brought into agreement both with the conditions of the Annelids as also with those of the Tracheates, and, in addition, we have the segmental organs, which have been transmitted from the Annelids.

Conditions are different among the Tardigrada, which present far less resemblance to the Annelids. In the first place we are acquainted with no Annelids whose bodies consist of so few segments as is the case among the Bear-animalcules. It is true that such might have existed, or the number of the segments might have been subsequently reduced. But the Tardigrada do not possess even a trace of true segmental organs, but are provided with Malpighian vessels in their stead, and consequently in this respect they must have receded far more from the Annelidan ancestors than even the existing species of *Peripatus*; they are in this point much more Arthropods than the latter. The muscu-

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* Kennel, "Die Verwandtschaftsverhältnisse der Arthropoden," Schriften herausg. von der Naturforscher-Gesellschaft bei der Universität Dorpat, vi.

lature of the Bear-animalcules, too, diverges from the dermal muscle-sheath of the Annelids much further than does the musculature of *Peripatus*; they have isolated muscle-strands, which run freely through the body-cavity, decussate, and are inserted at different points of the integument; in accordance with their small size these are of very simple structure and consist of few fibres. This arrangement reminds us forcibly of the distribution of the muscles in many highly developed Tracheates, which will be discussed later on. The nervous system of the Tardigrada can, it is true, be easily compared with that of the Annelids, but it also differs in no way from that of higher Tracheates, in which the sense-organs of the head are slightly or not at all developed. At any rate in its configuration as a chain of ganglia it surpasses that of *Peripatus*, which has a very irregular rope-ladder-like nervous system. On the other hand, however, the eyes of the Tardigrada are such insignificant dots of pigment that we can scarcely find more simple ones among the Annelids; they can only be regarded as rudimentary structures, but not as engaged in progressive development.

While the sexual organs of *Peripatus* can at once and by means of embryological proofs be traced back to those of the Annelids, and their ducts to segmental organs, this is not possible in the case of those of the Tardigrada, since in the first place they are unpaired, and, secondly, open dorsally into the posterior portion of the intestine. This condition also is more readily intelligible on the theory of reduction and degeneration, as I shall subsequently show.

If we regard the Tardigrada as an offshoot from the root of the Tracheata, we certainly need make no attempt to think out the conditions of their organization in their further development into Arthropods. If, however, they "most clearly express the transition from the Annelids to the air-breathing Arthropods," the ancestors which were common to them and the Tracheata would yet have to be supposed to have resembled them fairly closely. But here great difficulties crop up in relation to the appendages. The four pairs of appendages of the Tardigrada are post-oral, and are innervated from the ventral chain of ganglia, while the Tracheata nevertheless possess a pre-oral pair of appendages in the shape of the antennæ.

Now this pair of appendages must either have disappeared in the Tardigrada or it must be regarded as a new development in the rest of the Tracheata; for the first pair of leg-stumps of the Bear-animalcules is innervated from the first ventral ganglion. Should we wish to interpret the absence of the antennæ as due to reduction, which may well be the only possible explanation, it would follow that the first three pairs of appendages of the Tardigrada are homologous with the mouth-parts of the Tracheata, and only a single segment would be left for the body. This would entail the conclusion that the rest of the trunk-segments of the Tracheates have arisen in consequence of continued segmentation on the part of the common ancestors of Tardigrada and Tracheata. Although this would be an absolutely permissible supposition, we must nevertheless consider that in the *Peripatus*-like Protracheata we have animals which, with a larger number of segments, combine Annelidan characters even in a far greater degree, and consequently fulfil all demands that can be made upon transitional forms. Moreover all Myriapods, from which the rest of the Tracheata can be derived by the process of concentration of segments &c., possess altogether a larger number of segments and a fully developed head, the rudiments of which are already in process of formation in *Peripatus* in the shape of antennæ, jaws, and slime papillæ.

Let us now consider whether the peculiar conditions of the Tardigrada cannot after all be derived more easily and simply from higher Tracheates by the method of reduction and simplification. Let us just take the Tardigrade body as we see it—a segmented animal which, according to its nervous system, consists of five segments. It must certainly be admitted that we are acquainted with no Tracheate Arthropod which is composed of so few segments. But we nevertheless find in the entire Tracheate stem a reduction of the number of segments from the Myriapods upwards, which is brought about in part by the actual absence of posterior abdominal segments, and in part by fusions and intimate union of several segments. As a general rule among the higher Tracheata four cephalic, three thoracic, and a somewhat fluctuating number of abdominal segments are present; the latter, however, in the Mites and the true Spiders are fused into one piece, which is greatly reduced in the case of the former. A reduction such as this may have occurred in other Tracheata also. Moreover, we are acquainted with stages of Tracheates, namely their larvæ, in which the divisions of head, thorax, and abdomen are not differentiated; larvæ in which the appendages have disappeared in adaptation to certain conditions of existence (maggots); and, finally, larvæ in which new stumps of appendages, in the form of simple dermal protuberances provided with claws of different shapes, have appeared secondarily upon all the segments of the body or upon a portion of them. I merely recall the caterpillars with their "pro-legs" and many dipterous larvæ with leg-stumps. Most important of all is the fact that in **dipterous larvæ of this kind the entire head is wanting, since the four foremost segments of the body are invaginated and constitute the œsophagus of the larva.**

In the metamorphosis of the larva all portions of the head of the imago are formed in a reversed position out of rudiments in the wall of the larval œsophagus, and are everted in the pupa. That which is known to us as a maggot is merely the trunk, externally wholly unsegmented, enveloped in a resisting cuticle, and apodous or with a very variable number of secondary leg-stumps. If we imagine the trunk of such a dipterous larva reduced to four segments we have in essentials precisely the body of a Tardigrade.

In the secondary œsophageal tube formed by invagination of the four cephalic segments there lie in the case of the maggots of Diptera the two stylets of chitin as masticatory organs of local origin, not homologous with any appendages, precisely like the chitinous rods in the œsophagus of the Tardigrada. The musculature of a dipterous maggot is certainly more complicated than that of a Tardigrade, but exhibits so surprising a similarity in arrangement and distribution that we are involuntarily impelled to institute a comparison. It is true that the muscles of the Tardigrada are not transversely striated, but this, in the light of present views, will surely not carry much weight. In the larvæ of many Diptera (*Stratiomys*, Mycetophilidæ, &c.) leg-stumps occur in different numbers as independent new formations. I myself when a student, some seventeen years ago, found beneath a stone in the Black Forest a number of very peculiar dipterous larvæ, which I have never yet been able to determine and which bore upon the flat ventral surface four pairs of such leg-stumps provided with claws. Salivary glands and Malpighian vessels are present in the larvæ of Diptera. How greatly the condition of the alimentary canal can alter according to the mode of life is shown with the greatest distinctness precisely by Insect larvæ. Thus we next come to the tracheæ. These are, indeed, present in larvæ of Diptera, but the number of the stigmata is considerably reduced; that tracheæ, however, may disappear, especially in very small Arthropods which live in damp surroundings, is shown among others by the Acarina.

We have now only to deal with the nervous system and sexual organs.

The nervous system varies exceedingly in dipterous larvæ, even in those which we may designate as maggots. The supra-œsophageal ganglion is, in accordance with the invagination of the first segments, placed far back, while the ganglion-chain is sometimes exceedingly concentrated, forming a short band-shaped mass, from the lateral margins and hinder end of which the nerves radiate into the segments after the manner of a *cauda equina*—and sometimes also a well-developed chain. If we retain the last case and assume a great reduction in the number of body-segments, the conditions in the Tardigrades present no further difficulty.

Now, however, it is precisely among dipterous larvæ that we observe in a series of forms that they are **capable of reproduction as larvæ** (*Cecidomyia*). In these larvæ a head is never developed: it remains after a fashion latent for generations. The larval sexual organs, which are in this case only female ones, are situated, in the shape of small paired sacs, upon the dorsal side of the intestine and have no ducts; the differentiation of the germ-cells into egg- and nutritive cells appears to be abolished or at any rate not sharply expressed. Now if we were to suppose that larvæ of this kind had ceased to undergo their metamorphosis, that they always reproduced their species as larvæ, and that, in consequence of adaptation to the very peculiar conditions of existence in damp moss and water, they had become modified in one direction and had then undergone further development, we might regard them as constituting a transition to forms which we now know as Tardigrades—**Arthropods in the larval stage, without a head, and with a body consisting of a reduced number of segments, and bearing a few (secondary) leg-stumps.** In the course of this process a few peculiarities must naturally have received especial emphasis. In the first place, not only female but also male larvæ must have remained in this stage. Now we actually find, as, for instance, in the case of *Cecidomyia*, that after a series of pædogenetic and parthenogenetic larval generations the spontaneous production of male larvæ occurs, since finally both males and females appear as imagines. The idea that under certain circumstances male larvæ of this kind also failed to undergo metamorphosis must not be rejected offhand. We need simply and solely suppose that the sexual organs gradually redeveloped a duct—in the present case a short canal in communication with the rectum. And this supposition is certainly not outside the limits of what we otherwise concede to the capacity for modification shown by the animal body. It is likewise conceivable that independent efferent ducts, which were previously present, came into communication with the rectum through invagination of the posterior body-segments, while in this way the reduction in the number of the segments would also become more intelligible. The enigmatical "gland," which occurs in both sexes of Tardigrades (*cf.* Plate, *loc. cit.*), is perhaps nothing else than the degenerate second ovary or testis, just as in the case of birds also, at least in the female sex, only one half of the genital apparatus arrives at maturity.

Now it is by no means my intention to put forward dipterous larvæ as actually the ancestors of the Tardigrada; on the contrary, I merely selected these larvæ in particular because they combine in themselves a series of peculiarities which show how great the capacity for modification may be in such animals, and because these peculiarities occur in a precisely similar manner in the Tardigrada. Just as in the case of Diptera such very far-reaching secondary changes were possible in the larval stage in adaptation to certain conditions of existence, so this might equally well have happened in the case of the larvæ of other insects also of which we have lost all knowledge. I merely mean that, of all tracheate Arthropods with which we are at present acquainted, no single form so simply and so readily enables us to interpret the Tardigrade body as these very dipterous larvæ. I do not believe that the Tardigrades can be placed at the root of the tracheate stem or in the neighbourhood of it; for the conditions of their organization diverge more from those of the Annelids than do those of indisputable Tracheates of much higher rank. If my memory serves me it was once declared by Ray Lankester that in the case of animals of very small size but of relatively complicated structure we must first direct our thoughts towards degeneration and reduction from higher forms. If we derive the Tardigrada in the manner indicated above from pædogenetic and greatly modified Tracheate larvæ we can regard the entire body of these animals as an Arthropod trunk of four segments, of which the head ceased to be developed, and of the cephalic organs of which the supra-œsophageal ganglion is the sole remnant. The first three ganglia of the ventral cord, which in higher Arthropods are fused together to form the subœsophageal ganglion and innervate the mouth-parts, may very well in the course of time have degenerated and disappeared, since the organs which they had to supply were no longer developed. The four ganglionic centres of the Tardigrades may then correspond to three thoracic and one abdominal ganglion. If we consider that the young of many Myriapods leave the egg at a very early stage with quite a small number of segments, and only develop the remainder during free existence, we can also conceive that this may have been possible several times, and that such immature larvæ having ceased to develop at an early stage, and being remodelled after the fashion of the dipterous larvæ which we have been discussing, might have acquired the power of pædogenetic reproduction. I readily admit that our hypotheses are somewhat many in number; but there is not a single one among them which has not been actually observed in the Arthropod phylum itself, and more frequently in combinations. Whether the leg-stumps of the Tardigrades have arisen by degeneration from Arthropod appendages of their ancestors, or whether they may be new formations like the pro-legs and claspers of the caterpillars, is a question which is difficult to decide. Its solution, however, be it as it may, needs to alter nothing in the whole conception.

If we once more briefly sum up the points of agreement between the Tardigrades and greatly modified Tracheate larvæ, somewhat of the type of the maggots of *Cecidomyia*, we find:—absence of a head, chitinous stylets in the œsophageal tube, absence of any ciliated epithelium and of a dermal muscle-sheath, musculature broken up into isolated cords, supra-œsophageal ganglion and ventral ganglion-chain, simple structure of the sexual organs, and, lastly, Malpighian vessels. The differences depend upon further advanced degeneration of the Tardigrades, and include:—small number of the ganglia (disappearance of the parts of the subœsophageal ganglion), smooth musculature, absence of tracheæ and circulatory organs, and the probable reduction of the one germ-gland. As new formations we may perhaps regard the efferent duct of the sexual organs and, at any rate, the leg-stumps, if these are not an ancestral character.

Embryology as yet affords us no explanation; besides the development need no longer be of the typical Arthropod type, but may have secondarily undergone great modifications.

XXX.—*On some newly-described Jurassic and Cretaceous Lizards and Rhynchocephalians.* By G. A. BOULENGER.

IN a paper published two years ago (2), whilst dealing with a few points in the osteology of *Heloderma* and the systematic position of that genus of lizards, I ventured to express some views on the probable phylogeny of the order Squamata, which comprises the existing group of true lizards, chameleons, and snakes. I pointed out that the Cretaceous lizard *Hydrosaurus lesinensis*, regarded by some authors as a member of the family Varanidæ, agreed, so far as could be judged from the figures published by Kornhuber, with Owen's *Dolichosaurus*, and that the suborder Dolichosauria might prove to be the ancestral group from which the Lacertilia, Pythonomorpha, and Ophidia evolved. This opinion was founded on the archaic condition of the hind limbs and the number of cervical vertebræ; the presence of the zygosphenal articulation of the vertebræ, present in all Ophidia and several Lacertilia and Pythonomorpha, lent additional support to this hypothesis.

As I expected, my views have not had the approval of Dr. Baur, who, in a lately published paper on the skull of Mosasaurs (1), adheres to his previously expressed opinion that the Varanidæ, Mosasauridæ, and Helodermatidæ should be grouped together as a suborder "Platynota."

With regard to the structure of the foot, he denies any considerable difference between Kornhuber's *Hydrosaurus lesinensis*, which I referred to the Dolichosauria, and a true *Varanus*. But unless he contests the correctness of Kornhuber's restoration of the metatarsals and propodials, his statement does not refute my interpretation; the figures which I have reproduced (after Marsh and Kornhuber) speak for themselves. On the other hand, when he says that he has "no hesitation to assume that unguiculated limbs can be transformed into paddles with numerous phalanges," I entirely agree with him, and do not know that I have ever expressed any opinion to the contrary.

His other argument is that there is no evidence for the supposition that the number of cervical vertebræ after having increased in the Dolichosauria can have become gradually reduced again until the Rhiptoglossan number five was reached. If my critic admits, as I believe he does, that the Rhynchocephalia are descended from the Stegocephala, which have fewer than eight cervical vertebræ, and that the Rhiptoglossa are only an ultra-specialized branch of the typical Lacertilia, he cannot well argue against the probability of such a process of increase followed again by a reduction. In fact, if he will refer to one of his previous contributions to the phylogeny of the Reptilia, he will find that he has no difficulty in assuming that the Chelonians, with eight cervicals, may have been descended from Plesiosaurians with very numerous cervicals, the latter having been, as he himself admits, derived from short-necked forms. That he now holds "All forms which show a greater or smaller number of cervicals [to] have with very little doubt developed from forms with eight cervicals" shows that his views have undergone a considerable change since 1887, when, commenting on Parker's discovery of at least fifteen somatomes in the cervical region of the embryo of *Chelone*, he regards the latter author's statement, that "This free suppression of segments suggests a great secular modification by shortening of a form not unlike a Plesiosaur," as a "proof of the affinity of the Testudinata and Sauropterygia." What Dr. Baur proves with so much assurance on one occasion he himself pretends to disprove on the next, without even referring to the position he has previously taken up.

Two recently published contributions throw fresh light on the Jurassic and Cretaceous Squamata, and suggest some further remarks on the subject.

The first of these contributions is a paper by Gorjanović-Kramberger (5), who, ignoring my previously published note and reasoning from a different point of view, arrives at results very similar to mine in dealing with the systematic position of some Cretaceous lizards from Dalmatia.

He describes a new form, *Aigialosaurus*, which shows points of affinity to the Dolichosauria, the Pythonomorpha, and the Varanoid Lacertilia, and proposes to establish a group named Ophiosauria to comprise the Aigialosauridæ and Dolichosauridæ. It is needless to observe that the term Ophiosauria must be superseded by that of Dolichosauria, which is of older standing, although Kramberger appears to be ignorant of its existence. His definition of the group is, besides, deficient in truly diagnostic characters.

The *Hydrosaurus lesinensis* of Kornhuber is incidentally dealt with, and the genus *Pontosaurus* is established for it in the family Aigialosauridæ, which is stated to be distinguished from the Dolichosauridæ by the number, 7 to 9, of cervical vertebræ. However, it seems clear to me, after reexamination of the figure given by Kornhuber, that *H. lesinensis* possessed about 15 cervical vertebræ, and I am still at a loss to find how it is to be generically distinguished from *Dolichosaurus*. But this is a matter which cannot well be dealt with without comparing the specimens themselves; therefore the genus *Pontosaurus* may be accepted provisionally, provided it be not identical with *Acteosaurus* of H. v. Meyer or *Adriosaurus* of Seeley.

Aigialosaurus, of which the figure of a nearly perfect specimen is given, is a remarkable lizard, with somewhat the physiognomy of a Monitor or *Varanus*, but with the jugal in contact with the postfrontal and closing the orbit behind, shorter and stouter ribs, and limbs much of the same type as in *Pontosaurus*, although more developed. The quadrate is shown to differ considerably from that of the Varanidæ and to agree very closely with that of Mosasaurs. Kramberger is therefore fully justified in regarding this type as one of the original stock from which the Varanoids and the Mosasaurs were derived.

There are a few points in Kramberger's description which need criticism. First, as regards the number of cervical vertebræ: whilst admitting that, owing to the sternum not being preserved, it is difficult to decide which is the first dorsal vertebra (taking as such that which bears the first sternal rib), the author assumes that only seven vertebræ are to be reckoned as cervicals, his reason being that the scapula in his specimen is situated on a line with the fifth to seventh vertebræ. In a specimen of *Varanus niloticus* which I have before me I find that the scapula corresponds to the sixth and seventh vertebræ, and yet nine cervicals exist; besides, the last cervical is a little shorter than the first dorsal, the difference between the two being about the same as represented in *d.* 2 and *d.* 3 of Kramberger's figure. I would therefore say that *Aigialosaurus* had nine cervical vertebræ, or even ten in the event of the atlas having been overlooked.

A second criticism I have to make is with respect to the importance attached by Kramberger to the great development of the cervical autogenous hypapophyses of his reptile as differentiating it from existing lizards; for on the five anterior vertebræ of the Agamoid *Physignathus Lesueurii* I find them quite as long as in *Aigialosaurus*, and other recent lizards approach this condition.

An interesting point in the specimen figured is the presence, to which, however, no allusion is made in the text, of double parapophyses to the second sacral and the first two caudal vertebræ, thus representing the well-known "lymphapophyses" of snakes. On this occasion I would remark that Dollo, in a recent contribution, is entirely mistaken when he thinks that the lymphapophyses of snakes and apodal lizards represent the combined ribs and hæmapophyses. A glance at the skeleton of a viper, to mention no other examples, shows that the lymphapophyses may coexist with the paired hypapophyses on one and the same vertebra. His statement, "les lymphapophyses ne coexistent jamais sur la même vertèbre, soit avec les côtes, soit avec les hæmapophyses," is therefore erroneous; and his deductions, so far as this point is concerned, consequently fall to the ground.

We have so long been ignorant of any undoubted pre-Tertiary Lacertilian in the restricted sense, that much importance attaches to the description of the Upper Jurassic

Euposaurus Thiollierii, Lortet, which has just appeared in Dr. Lortet's splendidly illustrated memoir on the fossil reptiles of the Rhone Basin (6). Although the fossil is unaccountably referred to the Rhynchocephalia, and even to the family Sphenodontidæ, which, in the French author's classification, includes *Homœosaurus*, there can be no doubt that we have here to do with a true lizard, as is evidenced by the absence of a quadrato-jugal arch and of a plastron. The pleurodont dentition, the absence of supra-temporal fossæ, the non-dilatation of the clavicles, are characters which approximate *Euposaurus* to the Anguidæ. The interclavicle (" sternum " of Lortet) is unfortunately not preserved. A curious oversight is noticeable in the description of this lizard, the fifth toe being described as the hallux, which is thus stated to be opposable to the other digits, whereas in reality the pes does not differ from that of an ordinary lizard.

Of still greater interest is Lortet's account and figure of *Pleurosaurus Goldfussii*, H. v. Meyer, likewise referred to the Sphenodontidæ. It is, however, quite clear that the cranial characters are not Rhynchocephalian. The temporal arch appears to be essentially of a Lacertilian type and to correspond with what is found in the Agamidæ. But the structure of the limbs is primitive, agreeing in the tibia and ulna and the metatarsals with the Dolichosauria and Proterosauria; and as the specimens described by H. v. Meyer show a plastron in the form of fine riblets, which are, however, not preserved in Lortet's specimen, *Pleurosaurus* should be regarded as the type of a distinct order of reptiles, combining characters of the Proterosaurian Rhynchocephalia and Squamata, for which the name Acrosauria, proposed by H. v. Meyer in 1860, may be used.

The number of cervical vertebræ in *Pleurosaurus* is stated by Lortet to be only five. I have to repeat the criticism made above respecting Kramberger's *Aigialosaurus*, and to add that the first rib-bearing vertebra does not represent the atlas; this vertebra is not even entirely concealed in Lortet's specimen. Two small bones visible behind the occiput are, in my opinion, the neuroids of the atlas. By further adding to the neck the two vertebræ named by Lortet first and second dorsal we have eight cervicals instead of five.

Dr. Lortet's memoir is also rich in information respecting the Rhynchocephalian genera *Homœosaurus* and *Sauranodon* (which name must yield to the prior *Saphæosaurus*). The latter genus was very imperfectly known; but the beautiful figures and the detailed description now published leave little to desire, although some important characters shown by the figures are not alluded to in the text. A new family, Sauranodontes, is established by Dr. Lortet for its reception, and is chiefly founded on the total absence of teeth and the procœlous vertebræ. In dealing with the latter character the author curiously contradicts himself, for in the definition of the family (p. 29) the vertebral centra are stated to be concave behind, whilst further on (p. 53) the reverse is described. That the latter statement is the correct one is shown by the figures on pl. iii. The skull, as in the Rhynchosauridæ, has no parietal foramen, and the bones described as the posterior portions of the parietals appear to be the supra-temporals, distinct from the squamosals.

The position of this new family in the system is indicated in the following revised scheme of the classification proposed by me in 1891 (3). The Champsosauridæ, first included in the Rhynchocephalia vera, are now shifted to the Proterosauria, in accordance with the recent researches of Dollo (4), who has shown these reptiles to be related to *Proterosaurus*.

Order **RHYNCHOCEPHALIA.**

Suborder I. PROTEROSAURIA.

Each transverse segment of the plastron composed of numerous paired pieces. Pubis and ischium plate-like. Fifth metatarsal not modified.

A. Nasal openings distinct.

Vertebræ conically excavated at either end, with persistent notochord, all with intervertebral hypapophyses; limb-bones without condyles; humerus with entepicondylar foramen.............................. 1. PALÆOHATTERIIDÆ.

Vertebræ fully ossified, cervicals opisthocœlous, dorsals biconcave; no hypapophyses between the dorsal vertebræ; limb-bones with condyles; humerus with ectepicondylar foramen or groove .... 2. PROTEROSAURIDÆ.

B. Nasal opening single; vertebræ fully ossified, feebly biconcave; no hypapophyses between the dorsal vertebræ; humerus with ectepicondylar groove .. 3. CHAMPSOSAURIDÆ.

Suborder II. RHYNCHOCEPHALIA VERA.

Each transverse segment of the plastron composed of three pieces, a median angulate and a pair of lateral. Pubis and ischium elongate and fifth metatarsal modified, as in the Lacertilia.

A. Jaws toothed; vertebræ amphicœlous.

a. Nasal openings distinct; mandible with coronoid process, the rami not united by suture. Vertebræ deeply biconcave.

Humerus with ectepicondylar and entepicondylar foramen; ribs with uncinate processes; all the vertebræ with intercentral hypapophyses .... 4. HATTERIIDÆ.

Humerus with entepicondylar foramen; ribs without uncinate processes; no hypapophyses between the dorsal vertebræ...... 5. HOMŒOSAURIDÆ.

b. Nasal opening single. Mandible without coronoid process, the rami united in a solid symphysis; vertebræ feebly biconcave; no hypapophyses between the dorsal vertebræ. Humerus with ectepicondylar foramen or groove .... 6. RHYNCHOSAURIDÆ.

B. Jaws toothless. Vertebræ procœlous. Mandible without coronoid process, the rami united in a solid symphysis. Humerus with ectepicondylar foramen .... 7. SAURANODONTIDÆ.

References.

(1) BAUR, G.—"On the Morphology of the Skull in the Mosasauridæ," Journ. of Morphol. vii., 1892, pp. 1–22, pls. i. and ii.

(2) BOULENGER, G. A.—"Notes on the Osteology of *Heloderma horridum* and *H. suspectum*, with Remarks on the Systematic Position of the Helodermatidæ," Proc. Zool. Soc. 1891, pp. 109–118.

(3) BOULENGER, G. A.—"On British Remains of *Homœosaurus*, with Remarks on the Classification of the Rhynchocephalia," *t. c.* pp. 167–172.

(4) DOLLO, L.—"Nouvelle Note sur le Champsosaure," Bull. Soc. Géol. Belg. v., 1892, pp. 5–53, pls. vi.–viii.

(5) GORJANOVIĆ-KRAMBERGER, C.—"*Aigialosaurus*, eine neue Eidechse aus den Kreideschiefern der Insel Lesina, mit Rücksicht auf die bereits beschriebenen Lacertiden von Comen und Lesina," Glasnik Soc. Hist.-Nat. Croat. vii., 1892, pp. 74–106, pls. iii. and iv.

(6) LORTET, L.—"Les Reptiles fossiles du Bassin du Rhône," Arch. Mus. Hist. Nat. Lyon, v., 1892, 139 pp., 16 pls.

XXXI.—*On some new or rare Scottish Entomostraca.* By THOMAS SCOTT, F.L.S., Naturalist to the Fishery Board for Scotland, and ANDREW SCOTT.

[Plates VII. & VIII.]

PARARTOTROGUS, gen. nov. (provisional name).

Anterior and posterior antennæ and mouth-organs as in *Artotrogus*, Boeck, except that the siphon is rudimentary. First pair of swimming-feet with both branches two-jointed;

third pair with both branches three-jointed; fourth pair with outer branch three-, inner branch two-jointed; fifth pair rudimentary.

This genus has been provisionally instituted to include a species closely related to *Artotrogus*, but from which it is at once distinguished by the structure of the swimming-feet and the rudimentary siphon.

Parartotrogus Richardi, sp. n. (Pl. VII. figs. 1–11.)

Length exclusive of tail-setæ ·5 millim. Seen from above the first body-segment is subrhomboid, its greatest breadth being equal to about one and an eighth times the length; forehead slightly produced, truncate. Anterior antennæ short, moderately stout, nine-jointed, the second joint considerably longer than any of the others; the formula shows the relative length of the joints—

$$\frac{12—20—6—5—6—10—12—13—14}{1—2—3—4—5—6—7—8—9}.$$

The antennæ when bent back upon the body are scarcely half the length of the first segment. Posterior antennæ four-jointed, the third joint nearly twice the length of the preceding one and three times longer than the next; armed with a strong terminal claw, hooked at the apex; a rudimentary one-jointed secondary branch springs from the middle of the second joint. Siphon very small. Mandibles small, stylet-shaped. Maxillæ small, with two one-jointed spiniferous branches, one branch much smaller than the other. Anterior and posterior foot-jaws nearly as in *Artotrogus magniceps*, Brady. Both branches of first pair of swimming-feet two-jointed, the last joint of both branches (but especially of the inner branches) dilated and bearing several plain setæ; (?) third and fourth pairs as in *Lichomolgus fucicolus*, Brady, but more slender and with the marginal and terminal spines broadly dagger-shaped; fifth pair small, bilobed, furnished with a few apical setæ. Ovisacs two, large. No males were observed.

Remarks. Only three pairs of swimming-feet could be observed, even after the most careful dissection of several specimens; it appeared to be the second pair that was wanting, as a considerable hiatus existed between the first pair and the next, much greater than between the fifth and the preceding pair.

This species was first known to us in 1889, having been obtained in material dredged near Fidra Island, Firth of Forth. Since that time it has been occasionally observed not only in material from the locality named, but also from the "Fluke Hole," off St. Monans. Towards the end of June 1892 a quantity of dredged material from the vicinity of Fidra was being examined, when a specimen carrying two large ovisacs turned up—the only specimen with ovisacs that has been obtained. The discovery of this specimen set at rest to a great extent some doubts entertained by us regarding the maturity of those previously observed.

We have named this species in compliment to M. Jules Richard, of Paris, the eminent zoologist and student of the Entomostraca.

Lichomolgus concinnus, Scott. (Pl. VII. figs. 12–15.)

1892. *Lichomolgus concinnus*, Scott, Tenth Annual Report Fishery Board for Scotland, part iii. p. 261, pl. xi. figs. 25–33.

This species was described (*op. cit.*) from a single specimen, a female, obtained in material dredged off St. Monans, Firth of Forth, in the early part of last year.

Some time ago a specimen of *Doris* (?) *tuberculatus* was taken in the neighbourhood of Granton; and while it was being examined several copepod parasites were accidentally observed in the vicinity of the branchial appendages; the thorax of the copepods was of pale whitish colour, but they were otherwise nearly transparent and were almost undistinguishable from their surroundings.

A careful examination of some of the specimens showed that the *Doris* parasite agreed with *Lichomolgus concinnus* in all respects except that the distal angles of the fifth feet were acute instead of being rounded, and that the abdomen was slightly longer than is shown in the figure in the Fishery Board's Report; but these differences, which might be due to local causes, are comparatively unimportant.

No other specimen of the same species of *Doris* has since been obtained; we are therefore unable to say whether this *Lichomolgus* is commonly associated with the *Doris* or not, but its strongly clawed posterior antennæ and foot-jaws seem to indicate that it is at least semiparasitic in its habits, and it would be of some interest to know if it was confined to any particular species of *Doris*.

The St. Monans specimen, from which the species was described, may have become detached from some *Doris* during the operation of dredging.

MORARIA *, gen. nov. (provisional name).

Somewhat like *Cylindropsyllus*, Brady, in general form and structure, but the posterior foot-jaws are three-jointed; the outer branches of the fourth pair of swimming-feet in the female are similar to those of the second and third pairs, and the fifth pair are two-branched and nearly as in *Attheyella cryptorum*, Brady.

This genus is instituted, provisionally, to include an interesting Harpactid from Loch Morar, Argyleshire, having characters connecting the freshwater species *Attheyella cryptorum*, Brady, with the marine *Cylindropsyllus lævis*, Brady.

Moraria Anderson-Smithi, sp. n. (Pl. VIII. figs. 1–14.)

Female.—Length exclusive of tail-setæ ·62 millim. ($\frac{1}{40}$ inch). Body elongate-cylindrical. Anterior antennæ short, moderately stout, seven-jointed; the upper distal angle of the fourth joint is strongly produced, and forms the base of a stout olfactory appendage; the last joint is rather longer than any of the others. The relative length of the joints is shown in the formula—

$$\frac{6—8—6—5—5—7—10}{1—2—3—4—5—6—7}.$$

Posterior antennæ (fig. 5) small, three-jointed; a small one-jointed secondary branch, with a few small apical setæ, springs from the middle of the second joint. Mandibles with a moderately broad biting part, armed with five cylindrical teeth and a small seta; palp small, composed of a single two-jointed branch. Maxillæ simple; primary branch broadly truncate, with five moderately large apical spines; secondary appendage bilobed; the exterior and larger lobe bears a stout terminal spine, plumose on the distal half; the smaller lobe terminates in a plain spiniform seta. Anterior foot-jaws (fig. 8) short, stout, furnished with a terminal claw-like spine and two marginal processes, each process terminating in a moderately stout spine, and a curved spine-like seta plumose on the inner edge. Posterior foot-jaws three-jointed, the last joint being very short, and armed with a long terminal claw; the proximal half of the inner margin of the second joint is furnished with several short setæ; a stout, setiferous, spiniform appendage springs from the inner distal angle of the first joint. Outer branches of the first four pairs of swimming-

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* From Loch Morar, Argyleshire.

feet three-jointed, inner branches two-jointed; both branches of the first pair are of nearly equal length; the other three pairs, which are nearly alike, have the inner branches considerably shorter than the outer; all the branches are sparingly setiferous, but the terminal and lateral spines are elongate and taper gradually from a moderately broad base to the sharp-pointed apex; the inner branches of the first pair are furnished with a very long subapical seta in addition to the terminal spine. Fifth pair small, two-branched, nearly as in *Attheyella cryptorum*, Brady, but the terminal and marginal setæ are shorter and spiniform (fig. 13). The abdomen consists of four segments, but the first is composed of two segments coalesced. Caudal stylets about as long as the last abdominal segment. Operculum small, subconical, apex acuminate.

The male differs little from the female except in the form of the anterior antennæ, which are hinged and somewhat dilated; the upper margin of the third joint is produced near the middle into a small lobe-like process, which forms the base of a curved spiniform seta; a sensory filament springs from the upper distal angle of the same joint. A stout conical process with a slightly hooked extremity arises from the proximal half and extends somewhat beyond the end of the first joint of the inner branches of the second pair of swimming-feet. The principal branch of the fifth pair is broadly truncate at the apex and provided with two short, stout, terminal spines; the small secondary branch bears an elongate setiferous terminal spine and two setæ on the inner and outer margins. The male abdomen consists of five segments.

Hab. Loch Morar (a freshwater loch in Argyleshire), in material dredged in shallow water at the head of the loch and also to the west of South Tarbet; specimens were more frequent in material from the latter place than from the former.

This species is named in compliment to Mr. W. Anderson-Smith, one of the directors of the Fishery Board for Scotland, who, by his pen and otherwise, has done much to encourage the study of natural history in Scotland.

Note.—Besides *Moraria Anderson-Smithi*, now described, several other interesting Entomostraca were observed in the material from Loch Morar, two of which may be specially mentioned here, viz.:—*Cyclops Ewarti*, Brady, first described by Dr. Brady in the Sixth Annual Report of the Fishery Board for Scotland from specimens obtained in the upper reaches of the Forth in November 1887: this species has not since been observed till now; and its occurrence in Loch

Morar confirms the opinion expressed by Brady, that it had been carried down by some stream into the Forth. *Attheyella cryptorum*, Brady, a species described by Dr. Brady in the 'Journal of Microscopical Science,' 1868, from specimens obtained among the gelatinous algæ on the damp roof of the pit-workings of the low main, West Cramlington Colliery, near Newcastle. No record of any further occurrence of this species has been observed; and it is of some interest to find *Attheyella cryptorum* in the waters of Loch Morar.

Specimens of these two species were sent to Dr. Brady, who confirmed our identification of them.

EXPLANATION OF THE PLATES.

Plate VII.

Parartotrogus Richardi, gen. et sp. n.

Fig. 1. Female, dorsal view. × 126.
Fig. 2. Anterior antenna. × 253.
Fig. 3. Posterior antenna. × 253.
Fig. 4. Mandible. × 460.
Fig. 5. Maxilla. × 253.
Fig. 6. Anterior foot-jaw. × 253.
Fig. 7. Posterior foot-jaw. × 253.
Fig. 8. Foot of first pair. × 253.
Fig. 9. Foot of ? third pair. × 190.
Fig. 10. Foot of ? fourth pair. × 190.
Fig. 11. Abdomen and last thoracic segment. × 170 .

Lichomolgus concinnus, Scott.

Fig. 12. Female, dorsal view. × 43.
Fig. 13. Posterior foot-jaw, male. × 190.
Fig. 14. Foot of fifth pair. × 380.
Fig. 15. Abdomen and last thoracic segment. × 190.

Plate VIII.

Moraria Anderson-Smithi, gen. et sp. n.

Fig. 1. Female, dorsal view. × 80.
Fig. 2. Male, lateral view. × 80.
Fig. 3. Anterior antenna, female. × 380.
Fig. 4. Anterior antenna, male. × 380.
Fig. 5. Posterior antenna. × 500.
Fig. 6. Mandible and palp. × 760.
Fig. 7. Maxilla. × 760.
Fig. 8. Anterior foot-jaw. × 760.
Fig. 9. Posterior foot-jaw. × 760.
Fig. 10. Foot of first pair. × 760.
Fig. 11. Foot of second pair, male. × 760.
Fig. 12. Foot of fourth pair. × 760.
Fig. 13. Foot of fifth pair, female. × 760.
Fig. 14. Foot of fifth pair, male. × 760.

XXXII.—*Descriptions of Four new Species of Butterflies from Omei-shan, North-west China, in the Collection of H. Grose Smith.* By H. Grose Smith.

Euthalia strephon.

Upperside. Olivaceous green. Anterior wings crossed beyond the middle from the costal to the submedian nervures by a pale greenish-yellow band, widest on the costa, narrowest between the two upper median nervules; a small yellowish somewhat elongate spot near the costal margin and a larger oval spot of same colour at the outer edge of the band beneath it; the space between and on each side of the dark bars which cross the cell is also pale greenish yellow. Posterior wings with a pale greenish-yellow curved band following the contour of the outer margin from the middle of the costa, gradually narrowing and becoming obsolete towards the lowest median nervule; an oval dark ring crossing the cell and an indistinct submarginal row of dark green hastate spots.

Underside. Olivaceous yellow. On the anterior wings the yellowish-green band is more clearly defined and edged on each side with black, narrowly towards the costa, gradually and irregularly becoming broader towards the submedian nervure, where it ceases. Posterior wings with the pale greenish-yellow curved band as above, bordered on each side with olivaceous green, the space round the spots in the cell and on the outer margin being the same colour as the central band.

Expanse of wings $2\frac{1}{2}$ inches.

Nearest to *E. omeia*, Leech, which it resembles in colour, but the posterior wings are very different.

Five specimens were sent, apparently all males.

Euthalia irrubescens.

Male.—Upperside. Anterior wings with the basal half dark green, almost black, the outer half paler and slightly metallic, the veins, with streaks between them on the paler portion of the wings, being the same colour as the basal half; the cell is crossed in the middle by an irregular crimson bar, and there is another crimson bar, narrower and somewhat indistinct, at the end of the cell. Posterior wings the same colour as the basal half of the anterior wings, being paler across the disk and traversed by the dark veins with streaks between, as on the outer half of the anterior wings; two dark bars cross the cell, and there is a crimson elongate spot parallel with the outer margin between the submedian nervure and the lowest median nervule; the costal margin is pale and tinged with a bluish shade.

Underside similar to the upperside, but paler. Anterior wings with the crimson bars across and at the end of the cell wider and more distinct, and a small black spot below the median nervure at its junction with the lowest median nervule. Posterior wings with two crimson bars crossing the cell, two crimson spots below the costal nervure and upper median nervule respectively, another crimson spot on the costal margin near the precostal nervure, and another at the base; on the outer margin at the ends of the dark streaks between the veins is a row of crimson spots, those nearest the anal angle the most distinct and those in the middle nearly obsolete; the inner margin from the base to the anal angle is broadly edged with crimson. Antennæ black, the collar and palpi crimson.

Expanse of wings 2½ inches.

One specimen only.

Allied to *E. lubentina*, Cramer, var. *ludonia*, Staudinger, and *Whiteheadi*, Grose Smith.

Dichorragia nesseus.

Male.—Upperside. Dark bluish green. Anterior wings with the cell crossed by three black bars, that nearest the base nearly obsolete; beyond the cell, across the disk between the veins, is a curved row of indistinct greyish spots, the second and third of which are elongate; a submarginal row of sagittate grey markings, elongated inwardly to the extent of about one third of the wings, those towards the apex being more elongate and narrower than the others; there are no spots on the outer margin. Posterior wings more bluish green than the anterior wings and without grey markings, except three small hastate lines near the apex, with grey lines at their base, the lowest almost obsolete; beneath these, on the outer margin between the veins, is a series of black hastate spots.

Underside. Anterior wings bluish black, with the spots beyond the cell more distinct and the bars crossing the cell and a small spot beyond violaceous; the sagittate markings as on the upperside, but more distinct. Posterior wings olivaceous, the hastate spots at the apex as on the upperside, and the series of marginal black spots faintly and very narrowly bordered with white.

Expanse of wings 2⅝ inches.

One example.

Near to *D. nesimachus*, Boisduval, but considerably less maculate.

Lethe sicelides.

Male.—Upperside brown. Anterior wings with a broad darker brown indistinct band on the outer margin, and a large triangular indistinct sericeous patch, having its base on the inner margin and towards its apex extending beyond the end of the cell. Posterior wings without any tufts of hair within the cell; a submarginal row of four dark brown spots without any white centre, and surrounded by pale brown rings, the spot nearest the apex and the next but one being the largest.

Underside. Anterior wings with the cell crossed in the middle by two dark bars, the inner bar thicker than the outer and the space between being pale; a dark line at the end of the cell; two indistinct spots underneath each other towards the apex, with white centres and surrounded by pale rings; the other markings on the anterior and those on the posterior wings very nearly the same as on *L. sicelis*, Hewitson, but on the posterior wings the spot (in the submarginal row of spots) between the middle and lowest median nervules is much smaller than in *L. sicelis*, and the outer of the two narrow bands which cross the wings is bifid at its lower end and further apart from the inner band.

Expanse of wings 2½ inches.

Three specimens.

Very like *L. sicelis* in general appearance, but belonging to a different section of the genus. The large sericeous patch on the anterior wings and the absence of the tufts on the posterior wings distinguish it from that species.

XXXIII.—*On a New Species of* Aplysiidæ *from Jamaica.* By T. D. A. Cockerell, F.Z.S., Curator of the Museum of the Institute of Jamaica.

On January 19th Mr. Verona Carter brought to the museum a remarkable Aplysiid which he had caught at Kingston. The specimen was alive in a bowl of water, so I made a description of it before putting it in spirit. It was well that

I did so, as in alcohol (which was not too strong) it presents a shapeless mass which would defy description. Probably it is for this reason that the creature has not hitherto been described.

Owing to the absence of a shell and other characters the animal must be referred to the genus *Aclesia*, Rang, which has been considered peculiar to the East Indian region.

Aclesia intrapicta, sp. n.

Length about 4¼ inches. Body swollen, subglobose; foot flattened, posteriorly broad, terminally acute. Neck subcylindrical, moderately thick. Anterior pair of tentacles large, branched, antler-like, retractile. Posterior pair large, cylindrical, somewhat tapering, hollow, with open truncate ends, and with two whorls of spine-like soft lateral branches; these and the other tentacle-like processes on the body are also retractile. On the middle line of the neck, between the pairs of tentacles, is a short but broad branched filament. Epipodia contiguous in the middle line, but with the anterior and posterior parts separating alternately, forming wide cavities, in respiration. The anterior of these cavities serves for inspiration, the posterior for expiration, and the whole respiratory cycle takes about five seconds. Quite a jet of water can be thrown from the posterior orifice. Sides of epipodia and body with many branched processes, some short, others long, the largest resembling the anterior cephalic tentacles. On the sides of the epipodia are three longitudinal series of these processes—one dorsal, one subdorsal, one lateral or subpedal. Each row numbers four processes, and the rows are so placed that, as a general rule, the processes of the dorsal row are more posterior than the equivalent ones of the lateral row. Sides of foot with many processes.

Colour.—Prettily marbled with black and pale grey, dorsal portions of epipodia and sides of neck with most black. Most of the tentacles or processes tinged reddish, the larger ones mottled with white. Inside of epipodia grey with white dots. Sole finely speckled all over grey and white.

Described from a living specimen.

The anatomy, so far as examined, agrees in all important points with that of *Aplysia*. The narrow white fore-gut enlarges rapidly to form the big gizzard, which is pale red in colour. In this gizzard I found four (and a fifth rudimentary) little bodies, more or less triangular in outline, about 5 millim. diam., colour pale yellowish brown. These, like those described by Prof. Ray Lankester in *Aplysia*, are no doubt for crushing the food. Posteriorly to the gizzard the gut is grey and rather broad, winding round the large brown liver. The genitalia are somewhat ordinary, but rather curious for their bright colour, which suggested the specific name I have adopted. The albuminiparous gland and hermaphrodite duct are pale ochreous yellow, as is usual, but the gland has on one surface a large elongated patch of bright red, which does not remain well in alcohol. The ovotestis is large and irregularly globular, yellow-green in colour, with two blackish broad sulci. A strong ligament has its origin on the ovotestis, close to the beginning of the hermaphrodite duct.

It is perhaps this species that has sometimes been observed here and taken for a true *Aplysia*. Gosse, in his 'Naturalists' Sojourn in Jamaica,' p. 55, and Mr. E. A. Andrews, in the 'Johns Hopkins University Circular,' April 1892, both refer to the occurrence of an *Aplysia* (species not identified) at Jamaica.

Institute of Jamaica,
Kingstown, Jamaica,
Jan. 21, 1893.

XXXIV.—*On the Embryology of the Mites: Segmentation of the Ovum, Origin of the Germinal Layers, and Development of the Appendages in* Ixodes. By Julius Wagner, of St. Petersburg *.

Our knowledge of the processes which take place in the ovum of the Mites during its development is very limited. The causes of this are to be found on the one hand in the small size of the object, and on the other in the properties of the ovum, such as the thickness of the chorion and the brittleness of the yolk when hardened in alcohol, owing to the largeness of the yolk-spheres.

Ixodes, upon which my investigations were conducted, is a comparatively convenient subject—in the first place since its development proceeds somewhat slowly, and, secondly, because its ova do not require any great amount of attention and develop very well without especial precautions. When an *Ixodes* has once begun to deposit its ova it no longer stirs from the spot, and takes no notice if disturbed, as is often the

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* Translated from the 'Zoologischer Anzeiger, xv. Jahrg., no. 399 (August 29, 1892), pp. 316–320.

case when clusters of the ova are removed for the purpose of preservation. The deposition of the ova is a somewhat lengthy process, and continues almost to the time when the young emerge from the first batches; one and a half months, however, are requisite for development (in the northern Caucasus). Towards the end of the period of oviposition the tick is surrounded by a mass of eggs, which is twice or even three times the size of its body.

This at first sight apparently paradoxical phenomenon is due to the fact that the ova are heaped together in a loose and not in a compact mass.

1. Segmentation of the Ovum *.—The segmentation of the ovum of *Ixodes* differs from what was previously observed in the case of the Mites, in that the cells in process of division do not at first pass to the surface of the ovum (as is the case in *Tetranychus*, according to Claparède), though the yolk does not divide at the same time (as was observed by Robin and Megnin in Sarcoptidæ), since I found in the yolk four and six cells in course of fission, and on one occasion nine with resting nuclei. The process of segmentation consequently belongs to the partially interlecithal type. In the end the cells pass to the surface and form the blastoderm; no cells remain behind in the yolk.

2. Formation of the Endoderm.—Although in the first stages of development differences are noticeable between the individual cells of the blastoderm, they are at all events not pronounced and are connected by transitions in such a way that it is impossible to describe them precisely: the conditions, however, soon change. Certain cells are distinguished by their large nuclei, which usually occupy an oblique position with reference to the surface of the ovum; these nuclei take a fainter stain from carmine than those of the ordinary blastoderm cells, and contain in their interior from one to two nucleoli, which stand out sharply and are not present in the nuclei of the rest of the cells of the blastoderm. In one and the same series of sections, but still better in series which follow one another in succession, we observe how cells of this kind recede from the surface into the interior of the yolk and how the surrounding cells of the blastoderm close up above them. These cells constitute the so-called yolk-cells. As

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* Before the segmentation I also observed the extrusion of two directive corpuscles; in *Ixodes* this takes place prior to the deposition of the ova.

regards the region where the yolk-cells are differentiated, no regularity whatever can be detected; they are formed over the entire surface of the ovum. At the same time, however, certain of these cells form a cluster on the dorsal side of the ovum nearer the posterior end. They appear not to participate in the formation of the yolk-cells, but represent the remaining portion of the endoderm.

3. **Formation of the Mesoderm.**—At the stage which immediately precedes the appearance of the appendages mesoderm cells become visible at the sides of the above-mentioned endodermal cluster. From this we see that although this group of cells, which in its position corresponds with the *cumulus primitivus* of the spiders, does not represent the sole spot where the endoderm cells are formed, on the other hand it is just here that the mesoderm cells arise, which extend hence over the posterior end of the ovum on to the ventral surface, and along this towards the front. As regards the nature of the origin of the mesoderm cells, I find by a careful examination of the sections that at this spot no division in a tangential direction takes place; that is to say, that we here get an immigration of cells. On each side of the cluster of endodermal cells we find upon the surface of the ovum in the early stages of the development of the mesoderm a furrow-like depression, at the bottom of which an active immigration of the cells takes place. These depressions appear to me to correspond to the lateral margins of the germinal streak of Insects (Heider, *Hydrophilus*).

4. **Segmentation of the Yolk.**—As I have already indicated, no division of the yolk is observable during the segmentation of the ovum. Nevertheless when fresh ova are examined the yolk in the stages of the development of the appendages does not present a homogeneous structure; on the contrary, it is differentiated into separate polygonal portions of large size, which are divided from one another by clefts. In later stages, when the appendages attain a considerable length, this appearance stands out with especial distinctness. I was able to detect it later on in sections also. Thus we see that the yolk, subsequently to the migration of the yolk-cells, which are present at first in inconsiderable numbers (about thirty), splits up according to the number of these into separate portions, which are still preserved in the intestine of the larva shortly before its escape from the egg.

5. **Development of the Legs.**—The germinal streak of the Mites, like that of the Spiders, at the stage of the appearance of the appendages takes up the greater portion of the circumference of the ovum, passing over on to the dorsal surface

with its caudal and cephalic lobes. At this stage it already consists of two ectodermal ridges, which are separated by a band of flat cells and meet together at the ends of the elliptical ovum. When examined from the side the appendages appear very sharply defined. In addition to the usual three pairs of legs, which are characteristic of the larvæ of most of the Acarina and especially of Ixodidæ, the fourth and last pair is also developed in the embryo *. In the course of the development of the anterior legs this pair elongates and even exhibits an indistinct segmentation. Shortly before the larva is hatched it begins to degenerate rapidly; it decreases in length and becomes, so to speak, drawn in, so that soon no trace of it is left on the outside. But sections of the larva after its escape from the egg show that beneath the integument of the body on both sides, in the region of the transition of the mid-gut into the hind-gut (the excretory vesicle), there lies a cluster of cells, which represents the remains of the fourth pair of legs. From these clusters of cells also the fourth pair of appendages appears to develop on the transition of the larva into the nymph.

6. **Segmentation of the Abdomen and its Appendages.**—In the early stages of development the mesoderm consists of isolated groups of cells corresponding to the appendages; the mesoderm cells completely clothe the cavity of the appendages, but this cavity remains open to the yolk; the mesodermal elements are also localized in a similar manner behind the appendages, that is in the abdomen, since the fourth and last pair of legs must be regarded as appendages of the last thoracic segment. Behind the legs lie from five to six mesodermal groups. I did not determine their number precisely, because the sixth group passes quite gradually into the mesoderm of the caudal lobes. The internal segmentation in the region of the abdomen is consequently expressed through at least five segments. In the first segment, as in that of the thorax, the mesoderm lies in a layer; in the segments next following it forms a closed half-somite. Most developed are the second, third, and fourth segments, on each of which there is a projection on each side in the shape of a scarcely perceptible tubercle. These tubercles can only be observed in sectional preparations, and although they apparently do not develop into more noticeable protuberances, they yet without doubt represent structures homologous with the abdominal appendages of spiders.

7. **The Cephalic Appendages.**—I can positively assert that

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* *Cf.* Winkler, *Gamasus,* in no. vii. of Claus's 'Arbeiten.'

in front of the cheliceræ (*cf.* Jaworowsky, *Trochosa*) in the case of *Ixodes* no rudiments whatever of appendages are present. If nevertheless we observe the early stages of the development of the appendages, it is not difficult to discover that between the cheliceræ and pedipalpi there lies yet another pair of tubercles; consequently there are altogether three pairs of tubercles—a pair of cheliceræ, a pair of pedipalpi, and a pair which is situated between the two former. This latter pair arises later than all the rest of the appendages, and, judging from its position, bears a close relation to the pedipalpi. This is proved also by sections, since they show that the mesodermal elements of this pair of tubercles form a direct process of the mesoderm of the pedipalpi. In subsequent stages no trace of the tubercles is to be found: I have not yet elucidated their significance.

XXXV.—*Description of a new Buprestid from Madagascar in the Collection of the Hon. Walter Rothschild.* By C. J. GAHAN, M.A.

Chalcophoropsis Rothschildi, sp. n.

Viridi-metallica; capitis fronte subplana, valde inæqualiterque punctata, supra inter oculos canaliculato-depressa; pronoto fortiter inæqualiterque rugoso-punctato, medio longitudinaliter sat profundeque canaliculato, utrinque ante medium plaga levi, atro-violacea, paullo elevata, in depressione magna flavo-pollinosa, posita; scutello inviso; elytris cupreo-purpurascentibus, nitidis; costis octo, paullo elevatis (quarum interna prope basin utrinque brevissima) et punctis foveolatis numerosis albo-fasciculatis, obtectis, lateribus prope apicem breviter denticulatis; corpore subtus dense foveolato-punctato et albido-fasciculato; tarsis posticis articulo primo quam secundo manifeste longiore; antennarum articulis primo secundoque viridescentibus, tertio quartoque nigris, tertio quam quarto vix longiore, hoc apice intus compresso et dense punctulato (articuli ceteri desunt).

Long. 48, lat. (ad basin elytrorum) 15 mm.

Hab. S. Madagascar.

Head strongly and unevenly punctured in front, densely but much more feebly punctured behind; front rather flat below and with a median groove above between the eyes. Pronotum with a smooth dark violet and slightly raised area on each side just in front of the middle and about midway between the longitudinal groove and the lateral margin; this smooth plaga is surrounded by a much larger depressed area, which is covered by a yellowish powdery pubescence and is deepest behind, where it commences a little in front of the basal margin, but becomes shallower as it widens out around the smooth plaga, to narrow again in front, where it extends close up to the antero-lateral angle. The sides of the pronotum are subparallel or slightly divergent from the base up to the beginning of the posterior third, and thence converge with a rather gentle curve up to the anterior border. Elytra with numerous punctures, of which the larger ones bear each a minute tuft of white hairs; the sides are sinuately emarginate just in front of the middle, then slightly curve out, to narrow again up to the apex, near which each is furnished with four or five very short teeth; the innermost costa of each elytron extends back but a short distance from the base and approaches the suture, the second costa reaches from the base to the extreme apex, the two outer costæ are shorter and less distinct. Body underneath densely foveolate-punctured, the punctures bearing small fascicles of whitish hairs. Prosternal process flat, produced and narrowed behind to an obtuse point, which fits into a corresponding channel extending along the whole length of the mesosternum; the pits on its surface are more or less elongated.

This splendid Buprestid, which is named in honour of its possessor, to whom I owe the privilege of describing it, seems at first sight to belong to the group of the Psilopterides; but its structural characters show that it is foreign to this group. Taking all its characters into consideration, I do not see that it can be better placed than in the genus *Chalcophoropsis*. The scutellum, though invisible, has its position marked by a small opening or depression at the base of the elytra.

XXXVI.—*The Specific Rank of* Limax cinereo-niger, *Wolf*.

By Wm. Denison Roebuck, F.L.S., Hon. Secretary to the Conchological Society.

This slug, although very closely allied to *L. maximus*, L., differs so markedly from it in several particulars, both as regards external and internal characters, as to make it impossible for it to be looked upon as a mere colour-variety, as is somewhat baldly asserted by Mr. Collinge in a note in the 'Annals' for December last. The two slugs differ in their dentition, in the anatomy of the genital organs, and in the sculpture of the body, as well as in the coloration of the foot-sole and the body and shield; and, although some of these differences are individually not great, yet the sum or aggregate of them affords sufficient ground for considering *L. cinereo-niger* as entitled to rank as, at the very least, an incipient species, and for justifying malacologists in awarding to it the specific or subspecific rank which many authors give it.

To take the differences which exist, and first those in the anatomy of the genitalia. The importance of the reproductive organs of the Mollusca as a criterion for the distinction of species is universally recognized, and an examination of the very careful and accurate MS. figures of the genitalia of many individuals of both *L. maximus* and *L. cinereo-niger* which have been made by Mr. Charles Ashford, of Christchurch, Hants, shows that there are differences worthy of note. Mr. Ashford has found that the penis-sheath in *L. maximus* is very constant in its form, the upper part being much enlarged and peculiarly and rigidly flexed or bent upon itself, while in *L. cinereo-niger* the penis-sheath is longer and of tolerably equal width throughout, in which respect Mr. Ashford's figures tally with the one published by Schmidt. The sperm-duct in *L. cinereo-niger* is only very slightly attached to the oviduct in a part of its length, but in *L. maximus* moderate force is required to break the attachment. The relative sizes of other parts, as the albumen-gland, the ovotestis, &c., in sexually mature specimens is constantly different in the two forms. *L. cinereo-niger* has a larger and less deeply coloured ovo-testis, its average length in three specimens from different localities being 29·6 millim., the shortest one being 15 millim., while the greatest length Mr. Ashford has noted in *L. maximus* is 13 millim. and the average in a number of examples no more than 11 millim. *L. cinereo-niger* has a smaller and narrower albumen-gland, its average length in the same three specimens being 9·6 millim. and the greatest length noted 13 millim., while in *L. maximus* the average of sexually mature specimens is 20 millim., that of *all*, including both mature and immature, 15½ millim. The difference in the point of origin of the retractor muscle of the penis is referred to by Dr. Scharff and corroborated by other writers.

I am well aware that the differences of the two forms anatomically are not so great nor of such importance as F. Sordelli, whose paper was my authority for the statement I made in the 'Journal of Conchology' in 1883, attached to them; yet that there are differences is quite certain from the observations, which are both numerous and accurate, made by Mr. Ashford.

Another point of difference between the two forms under consideration is afforded by the radula, which is only second in importance to the reproductive organs as affording a criterion for the differentiation of molluscan species. Indeed some authors ascribe to it a much higher value in this regard. The differences in the radulæ of *L. maximus* and *L. cinereo-niger*, as figured by Heynemann, who was the acknowledged foremost limacologist of his time, in his paper "Ueber Schneckenzungen der Gattung *Limax*" (Mal. Blätt. 1863, pp. 200–218), are very striking. The teeth of *L. maximus* are simple in form nearly throughout, only the extreme outer teeth being shown as bifid, whereas in *L. cinereo-niger* the extreme outer teeth are simple, and the side-teeth are throughout bifid and even trifid.

The external characters, as I have pointed out more than once, are sufficiently distinctive to make *L. cinereo-niger* a particularly easy species to recognize. I have had ample opportunity for forming a judgment in this respect, as by far the greater proportion of the British specimens known have passed through my hands.

The sculpture of the two species is markedly different in character. In *L. maximus* the rugosities of the body are small, fine, and closely set in comparison with *L. cinereo-niger*, which has them large and coarse, with deep furrows separating them. In this respect it resembles *Arion ater*, and there can be little doubt that it is frequently mistaken for that species by inexperienced conchologists, more especially as the colour is often very similar, *L. cinereo-niger* being nearly always a very dark species, usually black, with but few pale markings, often none.

The differences in colour are important. One of the most striking characters of *L. cinereo-niger* is that the foot-sole is what may be loosely called "trifasciated," the two side-areas (longitudinal) being black, blackish, or dark-coloured, with the central area white. This is never the case with true *L. maximus*, but is a fairly constant character in *L. cinereo-niger*. I have on one or two occasions seen juvenile examples with the whole foot-sole white, but never adults.

The coloration of the shield offers another ready mark of distinction. *L. maximus* always has this part maculated or marbled; but in *L. cinereo-niger* there are no maculations or marblings, the shield being invariably of a uniform dark colour.

A less constant but very convenient character of *L. cinereo-*

niger is that the keel and a line continuing it along the back to where it joins the shield is the last part of the body to retain the light ground-colour. Except in the totally black variety (v. *maura*) *L. cinereo-niger* always has this keel and line more or less evident as a thin pale stripe.

This evidence will suffice to make it clear that, whatever views we may hold as to the specific or subspecific rank of *L. cinereo-niger*, it is not open for us to acquiesce in the statement that it "is simply one of the many colour-variations of the well-known *L. maximus*, L."

XXXVII.—*Note on the Variations of the Lateral Shields in the Three-spined Stickleback* (Gastrosteus aculeatus). By G. A. Boulenger.

Ever since Cuvier proceeded to divide the Sticklebacks into species according to the presence or absence and the development of the lateral armour, the question of the value of this character has been much discussed. Most modern European writers, with the exception of Blanchard and Sauvage, have refused to accept Cuvier's species as such, although they have usually retained them as varieties or subspecies. These supposed species are, however, maintained provisionally by American authors, Jordan not long ago remarking that he has not yet met with distinctly intermediate forms either on the Atlantic or Pacific coast. Bonizzi, Day, and Fatio have published results of investigations into the variations of the spines and shields in the smooth-tailed form from one locality; but the differences in the lateral armour in northern brackish-water specimens do not appear to have yet been subjected to a thorough statistical examination.

In July last I collected indiscriminately in a tidal pool close to Ostend Harbour sixty-six specimens of the three-spined stickleback, with the object of testing their characters, as I had observed that the three principal forms, viz. *G. trachurus*, *G. semiarmatus*, and *G. gymnurus*, occurred promiscuously both in and outside the harbour. The result is interesting, as showing how complete the gradation between the shielded and the smooth form is and how much the characters may differ on the two sides of one and the same specimen. I have therefore recorded the number of lateral shields in all the specimens, and arranged them in a series from the most perfectly armoured to the naked specimens. The numbers given refer to the shields on either side, those of the left side separated from those on the right by a dash, the cross indicating a gap between the thoracic and caudal shields.

The first group represents *G. trachurus*, with an uninterrupted series of shields from the shoulder to the end of the tail; the third the *G. semiarmatus*, with a naked gap between the thoracic shields and the caudals; the fifth the *G. gymnurus*, with the tail completely naked; whilst the second and fourth groups are of special interest as comprising individuals which belong to two different forms, according to whether the right or the left side is examined. It will be observed that the intermediate specimens (*G. semiarmatus*) are the most numerous.

I.

1. 32—31.
2. 30—30.
3. 30—29.

4-6. 29—29.
7, 8. 28—29.
9-13. 29—28.
14-16. 28—28.

II.

17. 18+7—30.
18. 30—12+10.
19. 13+7—29.
20. 28—17+10.
21. 28—14+6.

III.

22. 19+7—17+8.
23. 17+7—19+7.
24. 17+6—18+6.
25. 18+7—16+7.
26. 14+1+6—18+6.
27. 11+7—17+7.
28. 16+8—16+5.
29. 16+8—15+7.
30. 15+5—16+6.
31. 15+8—15+8.
32. 14+7—15+7.
33. 10+2+4—15+3.
34. 14+6—14+6.
35. 14+2—14+3.
36. 14+7—13+7.
37. 14+7—13+7.
38. 14+7—11+7.
39. 12+8—13+7.
40. 13+7—12+6.
41. 12+6—12+7.
42. 12+7—11+6.
43. 12+6—11+7.
44. 11+8—11+7.
45. 10+5—11+5.
46. 10+6—10+6.
47. 9+7—10+7.
48. 8+2—8+3.
49. 7+6—7+6.
50. 6+4—7+4.

IV.

51. 9+3—9.

V.

52. 12—12.

53, 54. 10—10.
55, 56. 7—7.
57. 7—6.
58, 59. 6—7.
60. 5—7.
61-64. 6—6.
65. 6—5.
66. 4—4.

XXXVIII.—*Description of a New Porcupine from East Africa.* By OLDFIELD THOMAS.

MR. F. J. JACKSON, the discoverer of so many new East-African mammals, picked up on the beach at Lamu the skull of a porcupine which, on comparison, appears to me to differ equally from the northern *Hystrix cristata*, L., and the southern *H. africæ-australis*, Pet. It is not fully adult, the last molar being still quite unused, although in position, and the tooth-change not having yet taken place; this change, however, occurs so late in life in the genus *Hystrix* that, judging by other skulls, we may suppose that this skull would not have greatly altered in size or form in later life.

The species may be called

Hystrix galeata, sp. n.

Skull approximating to that of *H. cristata* in the relative lengths of the nasals and frontals (see measurements below), but markedly different from that, as also from *H. africæ-australis*, by the reduced breadths of the same bones, especially in the interorbital region of the skull; so that the upper inflated part of the skull is more or less parallel-sided, instead of being broadly oval; when viewed from above this appearance is increased by the nasal bones being almost as broad anteriorly as posteriorly and by the ascending process of the premaxillæ being bowed out laterally; the muzzle therefore does not decrease evenly in breadth from the orbits forwards, but is parallel-sided to the level of the anterior point of junction of the nasals and premaxillæ. These processes are also much broader in a vertical direction than in the allied species, and in this respect approach the Indian *H. leucura*. In consequence also of the greater anterior breadth of the nasals and of the bowing outwards of the ascending premaxillary processes the nasal opening is very decidedly larger than in either of the other African species. Supraorbital edges of frontal straight or even slightly concave, the broadest point across the frontals being at the rudimentary postorbital processes, not at the edge of the lacrymal bones. In the side view the skull is remarkable for its extreme height at about $\underline{\text{m. 1}}$, from which point it slopes rapidly down, both forwards and backwards. Lower anterior root of zygoma broad and flattened, as in the northern, not styliform as in the southern species; general size and form of the ante-orbital foramen also very much as in the former species.

The molar teeth appear to be rather rounder in section, less narrow and elongated than in *H. cristata*; but much more material is needed before the value of this character can be at all properly estimated.

Measurements of a Gambian skull of *H. cristata*, of the typical skull of *H. galeata*, and of a Natal skull of *H. africæ-australis* (the last-named is fully adult, the other two have each not yet shed their mp.^{4}) :—

	H. cristata.	*H. galeata.*	*H. africæ-australis.*
Basal length	138	138	151
Zygomatic breadth	86	84	91
Length (round curve) of nasals	100	99	91
" " " of frontal	31	33	47*
Length of parietal (to extreme back of crest)	31	33	33*
Breadth of nasals at anterior end of naso-premaxillary suture	37·5	41	32
Breadth of nasals at posterior end	69·5	55	61
Interorbital breadth at edge of lacrymals	73	62·3	76
Interorbital breadth at rudimentary postorbital processes	68·5	66·5	70·6
Height of skull from palate between $\frac{\text{m. 1}}{}$	70	76	73·5
Least vertical diameter of lower anterior zygoma-root	5	5·5	1·7
Palate length	77	80	87
Mesial length of premaxillæ	29	25·7	28

These measurements show clearly the conspicuous differences between *H. galeata* and its allies in the relative proportions of the two interorbital breadths, anterior and posterior, in the shape of the nasals, and in the height of the skull, this last being the character from which is derived the name selected for the species.

Hab. Lamu, East Africa.

It is much to be hoped that more specimens of this interesting addition to the fauna of our East-African possessions will soon be brought to Europe, and it may be noted, as a hint to collectors, that a good series of skulls of different ages would be of especial value for the proper comparison of the species with its allies.

XXXIX.—*The Formation of the Skeletal Parts in Echinoderms.*

By Carl Chun, of Breslau [†].

The share of the mesoderm cells of Echinoderms in the building-up of the elements of the calcareous skeleton is altogether imperfectly understood. After it had already been shown by the older observers that the calcareous bodies are formed by the connective-tissue cells of the gelatinous central

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[*] Fronto-parietal suture closed and its position not quite certain.

[†] Translated from the 'Zoologischer Anzeiger,' xv. Jahrg., no. 408, December 26, 1892, pp. 470–474.

substance of the larvæ (it was scarcely likely that Selenka and Hérouard should still retain the ideas they formerly expressed as to an ectodermal origin of the calcareous bodies of the integument), it was recently sought by Selenka and Semon to determine the finer processes which take place in the secretion of the calcareous matter. According to Semon's account there arises within the skeletogenous mesoderm cell a tetrahedron, which subsequently develops into the triradiate body already observed by Selenka and passes out of the cell enveloped in a delicate membrane. The triradiate body is then approached by other mesoderm cells, which enlarge it, and by means of complicated furcations transform it into the definitive calcareous structure. Semon's observations have been confirmed by a careful memoir by H. Théel, which has just appeared ("Development of *Echinocyamus pusillus*," R. S. Upsala), in so far as Théel also claims the tetrahedron developing into a triradiate body as the foundation for the building-up of the skeletal parts of the *Pluteus*. It is true that there are material discrepancies in the observations as to the earliest origin of the tetrahedron. For [according to Théel] it is formed between at least three cells in a clear organic basal substance, and therefore from the outset proves itself to be an intercellular skeletal element, in the enlargement of which a large number of amœboid cells subsequently take part.

Now Semon is inclined to regard the tetrahedron, which develops into a body with three or four rays as the case may be, as the universal starting-point of the whole of the skeletal structures of Echinoderms. This view, then, would also sanction the converse inference, that the individual calcareous structures represent the product of a larger number of mesoderm cells. Nevertheless this assumption does not hold for all skeletal elements, inasmuch as, *e. g.*, the wheels of the *Auriculariæ* and the anchors and anchor-plates of the Synaptidæ, according to the statements of older investigators, which in essential points were recently confirmed by Semon and Ludwig, do not exhibit a tetrahedron and body with three or four rays as a starting-point. Semon therefore believes that the original condition became obliterated in these instances, and that the appearance of a star with six rays, which he gives as the basis of many calcareous wheels, implies a curtailment of the primitive arrangement. It would lead us too far, should we wish to discuss this conception here; against it the objection may always be advanced that the calcareous wheels clearly represent quite primitive structures, which not only furnish the distinctive character of the *Auricu-*

laria-larva and in the case of many Synaptidæ persist throughout life, but also, according to the discovery of Joh. Müller, which was confirmed by Ludwig for the Asteriadæ, by Semon for Ophiuridæ, and by Théel for Echinidæ, form the basis for the construction of the spines. Nevertheless it may appear to be open to question whether we are justified in homologizing with the wheels of the *Auricularia* the basal wheels of the spines, which are stated by Ludwig to arise from a triradiate body, and according to Théel's latest result again exhibit a tetrahedron as their starting-point. For, according to my own observations, the mode of formation of the larval calcareous wheels is so peculiar that it by no means allows itself to be forced into the scheme, which was constructed on the basis of our previous knowledge of the building-up of the calcareous skeletal parts from mesoderm cells.

As material for investigation I made use of the splendid *Auriculariæ* which I caught in different stages of development at the Canary Islands in the winter of 1888. As I shall describe the larvæ, which attained a length of 7 millim., in another place, I here dispense with an account of the complicated course of their ciliated bands and of their internal structure. Let it merely be remarked that the calcareous wheels appear relatively very late, but then accumulate in unusual abundance in the aboral tuft-shaped outgrowths of the lateral regions, further on along the entire dorsal surface, and much more scantily upon the ventral side. In order to check my observations the Mediterranean *Auriculariæ* were also examined, which, so far as regards the formation of the calcareous wheels, exhibit almost identical conditions.

At the time of the appearance of the first calcareous wheels the cellular elements of the gelatinous substance are sharply differentiated into skeletogenous and connective-tissue cells. The latter possess several long processes, which are much ramified and are interwoven almost after the manner of felt; the skeletogenous cells, on the contrary, are spherical and surrounded by a distinct membrane, in consequence of which they emit no pseudopodia. The sharp histological differentiation of the mesoderm cells, which was certainly preceded by an indifferent stage, may be essentially due to the fact that the calcareous bodies originate at a remarkably late period in comparison with what is found to be the case in other Echinoderm larvæ. The skeletogenous cells accumulate around the stone-canal and close beneath the ectodermal pavement epithelium. The latter with its nuclei is always distinctly discernible, even in *Auriculariæ* of the largest size, and there is no reason to suppose that it degenerates and is subsequently replaced (Semon) by means of the cells of the ciliated band or of the peripheral connective tissue.

A richly vacuolate plasma at once distinguishes the skeletogenous cells, the average size of which is ·01 millim. They rapidly grow to twice and thrice this bulk, while simultaneously the number of the cell-nuclei increases. In the same *Auricularia* we meet with all intermediate stages between uni- and multinucleate cells, which at first still retain a rounded contour, but subsequently flatten out on one side and become cup-shaped. The nuclei measure from ·003 to ·004 millim in length, and originally (so long as only from two to four are present) occupy a peripheral position; they afterwards increase to from six to eight in the case of the Mediterranean *Auriculariæ*, and to from twelve to eighteen in that of those from the Canary Islands, and form a central nuclear cluster.

When the cells have attained a size of ·03 millim. there appears within the old cell-membrane a new one, which has an undulating outline towards the circular margin and speedily assumes a star-shaped form. The tubular rays of the star which grow out are equal in calibre and meet the external membrane, arching forward somewhat at the points of contact. The longitudinal extension of the radially arranged outgrowths keeps pace with the increase in the size of the cell, and finally, when the cell attains a size of from ·06 to ·07 millim., the rays become united by a peripheral membranous ring. It is now impossible to mistake the mould of the subsequent calcareous wheel, prepared as it is by the complex folds of an internal membrane: the central portion with the cluster of nuclei corresponds to the nave, the tubes running out like the rays of a star represent the spokes, and the peripheral ring takes the place of the circumference (the felly) of the future calcareous wheel. Moreover the calx is actually secreted into this organic matrix formed by the skeletogenous cell, as into a mould, and in such a way that (as the older accounts already teach us) calcification takes place first in the nave, then in the spokes, and finally in the felly of the wheel. It is likewise in accordance with the theories which have recently been formulated as to the share of the nuclei in the vital processes of the cell that, corresponding with this centrifugal progress of the calcification, the majority of the cell-nuclei also separate from one another in a centrifugal direction, and in the case of the *Auriculariæ* from the Canary Islands come to lie in the acute angles between the spokes.

In rare instances they advance as far as the middle of the spokes or even to the periphery.

No secondary multiplication of the spokes of the wheel takes place; their number corresponds exactly with that of the undulating evaginations of the newly formed internal membrane, which develop into radiating tubes. As is well known, the number of the spokes varies; in the case of the *Auricularia* from the Canaries we find from thirteen to eighteen.

Since the diameter of the fully formed calcareous wheels is found to be from ·09 to ·1 millim., it follows that a tenfold enlargement of the diameter of the skeletogenous cells takes place, since the latter in the stage with a single nucleus only measure ·01 millim. Nevertheless after the secretion of the calcareous wheels they expand still further; for if we examine the wheels in alcohol preparations (the delicate points referred to can scarcely be demonstrated in glycerine and Canada balsam), we can distinguish a distant periphery formed by a delicate membrane, from which, alternating with the spokes and almost equalling them in length, membranous tubes arranged in the shape of a star run to the periphery of the wheel, where they usually exhibit flask-shaped expansions.

On careful decalcification of the wheels by means of weak chromic acid it is easy to show the nuclei and the contour of the wheel in the shape of a delicate membranous envelope within the skeletogenous cell.

The above statements as to the formation of the wheels in the *Auricularia* reveal a mode of development which at present appears to be unique. While the skeletal pieces of Echinoderms were hitherto essentially regarded as intercellular structures, the formation of which was due to several mobile amœboid cells (I am well aware that more recent observers are inclined to attribute the shape of the skeletal elements without hesitation to directly mechanical influences), we now find that **the form of the calcareous wheel is traced out within a multinucleate cell by means of an organic membrane which assumes complex folds, and that in this definitely circumscribed mould the casting of the hard parts ensues.**

XL.—*Preliminary Account of the Nephridia and Body-Cavity of the Larva of* Palæmonetes varians. By Edgar J. Allen, B.Sc., University College, London*.

The researches of which the present communication contains a brief summary were carried on during the summer of the present year at the Laboratory of the Marine Biological Association in Plymouth, where I occupied a table by appointment of the British Association Committee. The observations were made chiefly on larvæ of *Palæmonetes varians*, but other species have also been included, and will be mentioned in particular instances.

I. *The Nephridia.*

During the greater part of the larval life two pairs of nephridia are present—the green glands, which open at the bases of the second antennæ, and the shell-glands, which open at the bases of the second maxillæ.

The Green Gland.—In a larva of *Palæmonetes* which is a few days old the green gland has a form similar to that described by Weldon † and Marchal ‡ for the adult of *Virbius*, *Pandalus*, and *Crangon*, excepting that the remarkable enlargements of the bladder, which the former author has termed "nephroperitoneal sacs," are not as yet developed. The gland consists of an end sac, which communicates by means of a **U**-shaped tube with a very short ureter opening at the base of the antenna. The distal portion of the tube is slightly enlarged, and may be called the bladder. At the time of hatching of the larva the whole gland consists of a solid mass of cells, in which no cavity has appeared, although the portions which afterwards form the end sac and the tube can be distinguished, and the ureter and external opening are already present. Shortly after the larva has become free the cells separate and give rise to the lumen of the gland.

The later development of the green gland consists chiefly in the enlargement of the bladder, which grows at first inwards

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* From the 'Proceedings of the Royal Society,' vol. lii. no. 318, pp. 338–342.

† Weldon, W. F. R., "The Renal Organs of certain Decapod Crustacea," Quart. Journ. Micr. Sci. vol. xxxii., 1891.

‡ Marchal, P., "Recherches anatomiques et physiologiques sur l'appareil excréteur des Crustacés Décapodes," Arch. Zool. expér. vol. x., 1892.

towards the middle ventral line of the body, then upwards, within the œsophageal nerve-ring and anterior to the œsophagus, to the middle dorsal line, where it meets its fellow of the opposite side. The two bladders grow backwards over the stomach, subsequently fusing in the middle line to form the unpaired nephroperitoneal sac. This mode of development confirms the view as to the nature of the latter sac already arrived at by Weldon and Marchal from a comparative study of the renal organs of Decapods.

The Shell-Gland.—In a figure of a *Callianassa* larva in the *Mysis* stage Claus * inserts and names the shell-gland, opening at the base of the second maxilla. This is, I believe, the only recorded instance of the gland having been recognized in a Decapod, unless, indeed, the "segmental organ" described by Lebedinski † as opening at the base of the first maxillipede of the larva of *Eriphya spinifrons* and communicating with the body-cavity be the same organ.

In late embryos and at the time of hatching of the larva the shell-glands are the functional kidneys of *Palæmonetes* and *Palæmon*, the green gland being still without a lumen. The shell-gland of *Palæmonetes* consists of a comparatively short renal tube with a considerable lumen, which communicates internally with an end sac, and opens externally at the base of the second maxilla. The general form of the tube may be expressed by saying that it is **Y**-shaped, the two arms of the **Y** being in a horizontal plane, with the end sac attached to the internal one, whilst the leg of the **Y** is curved in a vertical plane, the concavity looking downwards and backwards. The histological structure of both end sac and renal tube is similar to that described by Grobben ‡ for the green gland of *Mysis*. The entrance from the end sac to the tube is guarded, however, by a valve formed of elongated cells of the end sac, which does not appear to have been found in other forms.

I have detected no trace of the shell-gland in young adults.

II. *The Body-Cavity.*

The Anterior Region of the Thorax.—A transverse section through the region of the second maxillæ of a *Palæmonetes*

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* Claus, C., "Neue Beiträge zur Morphologie der Crustaceen," Arb. Zool. Inst. Wien, vol. vi., 1886.

† Lebedinski, J., "Einige Untersuchungen über die Entwicklungsgeschichte der Seekrabben," Biol. Centralbl. vol. x., 1890.

‡ Grobben, C., "Die Antennendrüse der Crustaceen," Arb. Zool. Inst. Wien, vol. iii., 1881.

larva which is a few days old shows that the cavity enclosed by the external chitin and ectoderm may be divided into four regions:—a *dorsal sac*, surrounded by a definite layer of epithelium and within which the cephalic aorta lies, but which does not itself contain blood; a *central cavity*, in which the liver, intestine, and nerve-cord are found; two *lateral cavities*, separated from the central cavities by masses of muscle and bands of connective tissue, and which, in the region under consideration, contain the proximal ends of the shell-glands; and, fourthly, the *cavities of the limbs*, which contain the distal ends of the same organs. The cavities of the limbs communicate with the lateral cavities, and the latter frequently communicate with the central cavity by the disappearance of the connective-tissue bands. The central cavity, the lateral cavities, and the cavities of the limbs all contain blood.

The Dorsal Sac.—I have found the dorsal sac in *Palæmon serratus*, *Palæmonetes varians*, and *Crangon vulgaris*, and in the adult it attains a considerable size. If a dissection be made of an adult *Palæmon* the sac is readily seen. Anteriorly it appears as an elongated cylindrical tube lying upon the nephroperitoneal sac, and containing within it the cephalic aorta. Posteriorly it is very much enlarged, covering the front part of the ovaries, and running downwards on either side into the cavity which surrounds the intestine and liver. A similar condition of things is found in the adult *Palæmonetes*.

The dorsal sac does not contain blood. I have been led to this conclusion for the following reasons:—(1) In a large number of series of sections, both of larvæ and adults, I have never seen a blood-corpuscle within the sac. (2) The sac is completely closed and has no communication with the blood-sinuses of the body; in preserved specimens it contains a clot, which can generally be distinguished from the surrounding blood-clot. (3) I have observed carefully and for a long time living larvæ, and the space occupied by the sac has always been perfectly free from blood-corpuscles.

At its anterior end the dorsal sac is surrounded by a mass of tissue, from the external surface of which blood-corpuscles appear to be budding off. Before commencing this research Professor Weldon, to whom the existence of this tissue was known, and who has indicated it in his figures, suggested to me this view of its nature, and it is fully supported by my preparations.

Development of the Dorsal Sac.—In embryos of *Palæmonetes* in which the cephalic aorta is already formed the cells surrounding the latter are arranged in two layers, an internal and an external. Before the time of hatching arrives the cells of the external layer enlarge considerably and give rise to the appearance of a solid mass of cells upon either side of the aorta. The dorsal sac is formed by the hollowing out of these masses of cells. Two lateral cavities are thus formed, which are separated by the aorta. The protoplasm of the cells lining these cavities, which is at first gathered into masses around the nuclei, then spreads out into a thin sheet, drawing away from the lower portion of the aorta, and causing the two lateral cavities to unite ventrally and so form a single sac. In the region of the first and second maxillæ all the stages of the process just described may be seen. In the region anterior to this I have never actually observed the stage with two lateral cavities, the two having always united ventrally; but I do not doubt that the process is here the same as in the posterior region.

In one series of sections of a larva, preserved very soon after it had left the egg, the cavity was formed upon either side of and below the aorta, as far back as the anterior end of the segment of the first maxillæ, where for one section it was almost completely closed. Behind this the condition with two lateral cavities was found and persisted through the region of the first maxillæ, whilst in the region of the second maxillæ no cavity had yet opened, and solid masses of cells still lay upon either side of the aorta.

The further development of the dorsal sac consists mainly of an increase in its size. At its posterior end it grows backwards in a pair of lobes, which extend as far as the front end of the pericardium.

The Posterior Region of the Thorax.—The central and lateral cavities are here similar to those of the anterior region, whilst dorsal to them the pericardial chamber lies. This chamber is separated from the central body-cavity, as is already well known, by the pericardial septum, and it contains the heart. The genital organs are situated at the front end of the pericardium, immediately below the pericardial septum. In the just-hatched larva these consist of two masses of cells with large nuclei, each mass being enclosed in a sheath of mesoderm. I have not detected any trace of the genital ducts at this stage.

The Abdomen.—With regard to the abdomen, my sections confirm the accounts given by Milne-Edwards * and

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* Milne-Edwards, 'Histoire Naturelle des Crustacés,' Paris, 1834.

Claus*. There are two main sinuses, which run along its length: a dorsal sinus, in which the intestine lies, and a ventral one, which contains the nerve-cord. These two sinuses are generally separated by masses of muscle; but they communicate at intervals by means of lateral sinuses.

Theoretical Considerations.

The state of the body-cavity in the anterior region of the thorax of *Palæmonetes* may be compared with that of *Peripatus*, as described by Sedgwick †, at the time when the dorsal portions of the mesoblastic somites have attained their maximum development. Bearing in mind that the dorsal sac of *Palæmonetes* has been formed by the union of two lateral cavities, which lay on either side of the aorta, the differences between the two forms are very slight. The dorsal sac represents the two dorsal portions of the mesoblastic somites, whilst the central cavity, the lateral cavities, and the nephridia agree, with the one exception that the two lateral portions of the nerve-cord of *Peripatus* have united in the middle line in *Palæmonetes*, and in the process have passed out of the lateral cavities. The agreement is so close that it appears to me to be fully justifiable to homologize the various parts. If this be so, it follows that the dorsal sac of *Palæmonetes* is homologous with the dorsal portions of the mesoblastic somites of *Peripatus* and that its cavity is a true cœlom. The central and lateral cavities, together with the cavities of the legs, will represent the pseudocœle, and, being filled with blood, may be termed, with Lankester, *hæmocœle*.

Passing now to the posterior part of the thorax, the region of the heart, we find that the different cavities correspond with those which persist in the adult *Peripatus*. Heart, pericardium, and pericardial septum of *Palæmonetes* present exactly the same relations as in *Peripatus*, and are clearly homologous structures in the two animals. The central and lateral cavities only differ on account of the relative position of the nervous system, and this difference has already been accounted for. It must be noted, however, that in this region no nephridia are found in the cavities of the limbs. Beneath the anterior end of the pericardial septum are found, as has

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* Claus, C., "Zur Kenntniss der Kreislaufsorgane der Schizopoden und Decapoden," Arb. Zool. Inst. Wien, vol. v., 1884.

† Sedgwick, A., "The Development of the Cape Species of *Peripatus*: Parts I.-IV.," Quart. Journ. Micr. Sci. vols. xxv.-xxviii., 1885-88.

been already stated, the genital organs, and here also the comparison with *Peripatus* may be instituted. We find a similar agreement to that which existed in the other regions compared, and we may, with a considerable degree of probability, again homologize corresponding parts. The genital organs of *Palæmonetes* must then be regarded as the representatives, in this region, of the cœlom.

If the homologies here suggested are valid, the body-cavity relations of the Crustaceans under consideration may be stated briefly thus:—both enterocœle (true cœlom) and pseudocœle are present, the enterocœle consisting of the dorsal sac, the green gland, and shell-gland, or the end sacs of these organs, together with the genital organs and their ducts, whilst the pericardial septum may be regarded as equivalent to portions of the walls of another part of the same structure.

The pseudocœle consists of the heart and arteries, the pericardial cavity, the central cavity of the thorax, with the lateral cavities and the cavities of the limbs, and the various sinuses of the abdomen. The pseudocœle is filled with blood, and hence can be termed a hæmocœle.

I hope shortly to publish a more detailed account, with figures, of the relations described in this communication.

XLI.—*Note on a Case of Subdivision of the Median Fin in a Dipnoan Fish.* By A. SMITH WOODWARD, F.L.S.

PALÆONTOLOGY has demonstrated that in the Crossopterygian Teleostomatous fishes the process of subdivision of the median fin is usually different from that observed in the more specialized Actinopterygians. Whereas in the latter case portions of the fin-membrane disappear and the endoskeletal supports afterwards become atrophied, in the former case it is the almost universal rule that the supports of the dorsal and anal region become concentrated in clusters, and thus induce subdivision of the primitively continuous fin. The proximal fin-supports (axonosts) in each of these clusters ordinarily fuse into a single club-shaped element, and the distal supports (baseosts) are often more or less reduced in number by the same process*.

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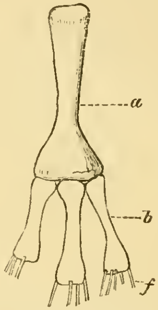
* Smith Woodward, 'Catalogue of Fossil Fishes in the British Museum,' part ii. (1891); and "The Evolution of Fins," Natural Science, vol. i. pp. 28–35 (1892).

Such being the arrangement in the Crossopterygii, it is of much interest to be able to institute comparisons with the Dipnoan fishes, which exhibit so many features of resemblance to the order just mentioned. Two Devonian genera, *Phaneropleuron* and *Dipterus*, are known to possess a discontinuous median fin; and quite lately specimens of the first of these genera have been found displaying all the fin-supports in undisturbed position. The fossils in question are referable to *Phaneropleuron curtum*, were obtained from the Upper Devonian of Canada, and have been acquired by the British Museum.

It now appears that, at least in the case of the Dipnoan anal fin, the process of separation from the caudal is precisely similar to that observed in the Crossopterygii. As shown by the accompanying illustration the axonosts (*a*) are fused into a single club-shaped element, and there are three hour-glass-shaped baseosts (*b*) of nearly equal size. Round the distal ends of these cartilages the clusters of dermal fin-rays (*f*) overlap in the usual manner. The same arrangement is also indicated in the figures of *Phaneropleuron curtum* already published by Whiteaves *; but, owing to the considerable displacement of the fin-supports in all the specimens at the disposal of that author, the peculiarity now described does not appear to have been observed.



Skeleton of Anal Fin of *Phaneropleuron curtum*, from the Upper Devonian, Scaumenac Bay, P. Q., Canada. *a*, axonost; *b*, baseosts; *f*, bases of fin-rays. [Brit. Mus. no. P. 6785.]

When specimens of *Dipterus* showing the fin-supports have been discovered the same phenomenon will doubtless be met with also in that genus; but as yet there is unfortunately no evidence on the subject.

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* J. F. Whiteaves, "Illustrations of the Fossil Fishes of the Devonian Rocks of Canada.—Part I.," Trans. Roy. Soc. Canada, vol. iv. sect. iv. p. 108, pl. x. fig. 2.

XLII.—*On the Mechanical Genesis of the Scales of Fishes.* By JOHN A. RYDER*.

FOURTEEN years ago the present writer suggested that the slow metamorphosis of the forms of the crowns of the teeth of Mammalia † in the course of a vast number of successive generations might be ascribed to the continuous, slow, and cumulative action of mechanical strains and pressures in definite directions, resulting in the production of permanent stresses and consequent changes in the forms of the crowns, especially of the molar series. The evidence since accumulated from vertebrate palæontology and anatomy has served to strengthen the belief that such an hypothesis cannot be dismissed as useless until a better one has been offered in its stead. The present paper is an attempt to apply somewhat analogous reasoning to a somewhat simpler but no less interesting problem in morphogenesis.

The mechanical hypothesis now to be offered respecting the genesis of the scales of fishes accounts for the origin of such scales from a continuous subepidermal matrix, which may be regarded as a basement-membrane. Such a matrix is found to actually exist in some forms at an early stage just beneath the epidermis. It is thickest on the dorsal and lateral aspects of the body, as is seen in sections of the young of the scaleless *Batrachus tau*, for example. Such a matrix also exists in the larval stages of other scale-bearing forms, and may be continuous with the very attenuated basement-membrane from which the actinotrichia or primordial fin-rays of embryo fishes seem to be in part differentiated. Such a matrix is almost coextensive with the whole epidermal layer of the young of many types of fishes, just at the time when the scales commence to be developed.

The hypothesis further accounts for the arrangement of the scales in longitudinal and in oblique rows in two directions. The oblique rows are arranged, as is well known, in a direction from above downward and backward, and also in the reverse direction from below upward and backward—that is, the scales may be counted in rows in three directions downward and forward as well as downward and backward, and,

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* From the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' 1892, pp. 219–224.

† "On the Mechanical Genesis of Tooth-forms," Proc. Acad. Nat. Sci. Philad. 1878.

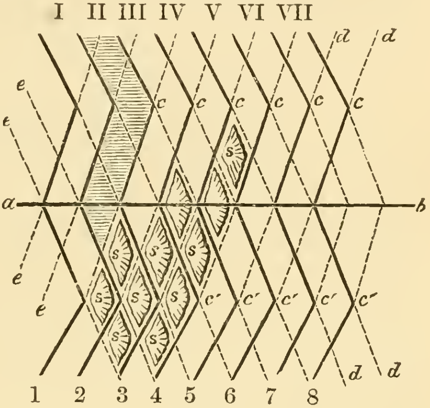
starting from any scale in any oblique row, they may be counted either forward or backward longitudinally or in conformity with the direction of the axis of the body of the fish. This is conspicuously the case in Clupeoids and some Cyprinoids.

In such archaic types as these, approximating the primitive isospondylous condition, it is also found that the number of scales in a longitudinal row corresponds on the sides of the body very exactly with the number of muscle-plates or somites of the body. It is also found that the myocommata or sheets of connective tissue intervening between the successive somites are attached with great firmness to the deeper layers of the skin or corium. Such a construction, together with the peculiar arrangement of the muscle-plates at the time the scales begin to develop, conditions the further growth of the scale matrix. This is affected in such a manner that the whole of the integument is thrown into definitely circumscribed areolæ during the ordinary movements of the fish in swimming. The central portions of each of these areolæ are left in a quiescent condition, while their margins are wrinkled or folded as a result of the current action of the lateral muscles of the body. In this wise each and every one of the dermal and epidermal areolæ are circumscribed by the action of the fish in the normal act of swimming. In each of the circumscribed areolæ a scale develops ; the continuity of its development with its fellows across the margins of the areola is prevented by the continual bendings or flexures to which the dermis is there subjected owing to the action of the muscles.

This will be better understood by referring to the accompanying diagram, representing the arrangementof the muscular somites of a Cyprinoid (*Carassius*) with their intervening myocommata as seen from the side when the skin with its scales is removed. Before proceeding further, however, it may be well to insist upon the fact that the rows of scales are found to conform to the successive somites. This is of itself significant. The careful interpretation of the facts from observation, however, discloses a very remarkable effect due to the peculiar arrangement of the muscle-plates.

As is well known, the muscular masses of the sides of the body of a fish are arranged in the form of two longitudinal trihedral columns separated along the middle line of the side *a* to *b* into a dorsal and ventral half. The somites entering into the composition of these ventral and dorsal masses were at first absolutely continuous across the longitudinal horizontal septum *a*, *b*. If we suppose the somites of the adult as developed from a continuous embryonic segment extending the

Fig. 1.



whole depth of the body, then will somites I, II, III, IV, V, &c. in the figure form two parallel series of muscular blocks above and below the line *a*, *b*. Each half-somite is also seen to present an acute apex directed backward at the points *c* and *c′* above and below the line *a*, *b*. The somites I, II, III, IV, and V are therefore sigmoid in outline as seen from the exterior. The myocommata or connective-tissue septa 1, 2, 3, 4, 5, 6, &c., which intervene between the somites, have a corresponding sigmoid arrangement. The sigmoid or ⋞-shaped myocommata and the myotomes are reciprocally coadapted to each other in configuration, like a nest of ⋞⋞⋞⋞'s turned upon their sides. If we further supposed that thin- and thick-legged ⋞'s alternated thus—**⋞**⋞**⋞**⋞**⋞**⋞—we might suppose the thin-legged ones to represent the myocommata and the thick-legged ones the muscle-plates or myotomes. The muscular fibres of the thick-legged **⋞**'s run longitudinally from the posterior surface of the myocomma immediately in front of it, to be inserted into the anterior face of the myocomma immediately behind it. The muscular tension is therefore exerted upon the opposite sides of the myocommata, and is thus propagated along the sides of the body from the head to the tail, from the first to the last myotome. But the tension upon the inner face of the skin is along the lines of insertion of the myocommata 1 *c′c*, 2 *c′c*, 3 *c′c*, &c.; this will serve to wrinkle the skin not only along the lines 1 *c′c*, 2 *c′c*, &c., but also to cause wrinkles to appear along the dotted lines *d*, *d′*, *e*, and *e′*. In this way it is easy to see that the whole lateral integument will be thrown into definitely circumscribed rhomboidal areolæ, in which separate overlapping scales, *s*, *s*, *s*, *s*, may appear. The wrinkles thus produced by the tension of myocommata upon the integuments of the body will cross each other and be reinforced at six points in the zigzag transverse course of each myocomma, viz.

twice at each of the points c and c' and along the line a, b, where the middle limb of the ≼ rests.

The only point which now remains to be discussed is the imbrication of the scales. This is also as readily accounted for as the delimitation of the scale-forming areolæ, s, s, s, and their trilinear arrangement in three directions in the convex surface of the integument by means of the mechanical hypothesis here outlined. If we were to make a longitudinal transverse section through a fish along the plane of the letters c, c, c, or c', c', c' of fig. 1, we should get a section like fig. 2, in which the myotomes M, M, M, &c. (fig. 2) were again found to be V-shaped on either side of the medial axis or vertebral column, c, c (fig. 2). This proves that the myotomes are really cones fitting into one another, and that, if we suppose the first one to be inserted into the base of the skull along the line A, B (fig. 2), that point becomes the anterior fulcrum or *point d'appui* of the whole muscular system. The tensions thus developed upon the skin along the successive myocommata 1, 2, 3, &c. (fig. 2) are such that the integument would be flexed inward opposite each myocomma as shown in the next figure on a larger scale, which represents the foldings of the integument at the surface of a part of fig. 2. Here in fig. 3 the myocommata m, i', m, i', m, &c. are seen to be inserted upon the internal face of the epidermis. The membrane m, m, m, m, acted upon by the muscular fibres of the myotomes M, M, M, will have the effect of pulling the integument inward in the direction of the arrows i', i', from the linear points of attachment of the myocommata to the integuments at i, i, i, toward the vertebral bodies V, V, V. In this manner will be developed the imbrication indicated by the heavy border along the posterior margins of the scales s, s, s in fig. 1, and in fig. 3 in longitudinal section through the scale-sacks or pockets at s, s, s.

Fig. 2.

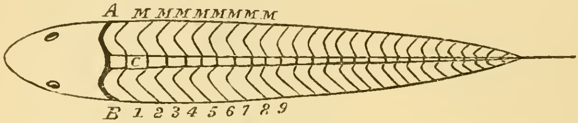
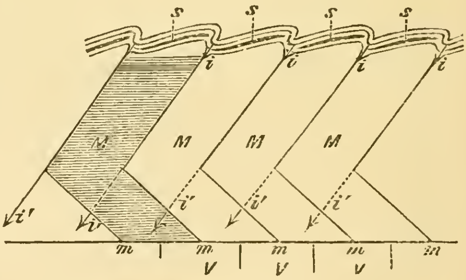


Fig. 3.



It will be clear that in the case considered the arrangement and imbrication of the scales is determined by the actions of the segmentally arranged muscles of the body. In other words, whatever has determined the development of somites has also, in the most clear and direct manner, determined the segmentally recurrent and peculiar trilinear and imbricated arrangement of the scales of many fishes. It may be urged in objection that heredity has determined the number, arrangement, and the development of the somites, and therefore the development of the scales is also a sequence of hereditary influences working thus indirectly. This view of the case may be admitted without invalidating the conclusion that, given the growing mechanism here described, the development of the scales would under any circumstances have been interfered with at the points where the integument was being continually flexed, wrinkled, or folded as it is around the integumentary areolæ wherein the scales are formed, as has been here proved to correspond with the facts.

Special types of squamation amongst fishes may require an interpretation different as to details from the foregoing; but it is probable that such special cases will rather tend to confirm than otherwise the views developed in this sketch of an hypothesis respecting the mechanical origin of the arrangement and imbrication of the scales of fishes. For example, one of the most extreme cases, that of the sturgeon, shows that the smaller integumentary plates between the large dorsal, lateral, and ventral rows conform to these lines of tension of the myocommata upon the integument. An even more instructive example is that of the common eel, in which the scales are oblong rhombs or parallelograms, arranged with their diameters in oblique lines, running in two directions conformably with the tensions, wrinklings, and foldings of the integuments produced by the oblique insertions of the muscles when the latter are brought into action. Other cases where the scales are very fine might be urged in objection, especially where several oblique rows of scales are found to correspond to each somite. Such parallel duplication of scale-rows, however, does not invalidate the principle, since the rows still conform to the lines of tension of the linear attachment of the myocommata to the integuments. The hypothesis may also be extended so as to consistently consider such forms as the pipe-fishes and other anomalous forms, where sluggish habits coupled with the almost exclusive use of the dorsal fin in swimming has rendered the lateral musculature of the body comparatively subordinate in function, and which may even lead to secondary fusion of somites and the consolidation of consecutive pairs or triplets of vertebral centra into single vertebral bodies.

Two conclusions of prime importance may be drawn from the hypothesis and the evidence here presented, namely:—

1. The scales of fishes bear a segmental relation to the remaining hard and soft parts, and are either repeated consecutively and in oblique rows corresponding to the number of segments, or they may be repeated in rows as multiples of the somites, or segmental reduction may occur which may affect the arrangement of the scales so as to reduce the number of rows below the number of somites indicated by the other soft and hard parts.

2. The peculiar manner of interdigitation of the muscular somites, as indicated by the sigmoid outline of the myocommata as seen from their outer faces, and the oblique direction of the membranes separating the muscular cones, has developed a mode of insertion of the myocommata upon the corium which has thrown the integument into rhombic areolæ during muscular contraction. These areolæ are in line in three directions, and the folds separating them, particularly at their posterior borders, are inflected in such a manner by muscular tensions, due to the arrangement of muscular cones, as to induce the condition of imbrication so characteristic of the squamation of many fishes.

XLIII.—*Upon the Identity of some of the Types of Diplopoda contained in the Collection of the British Museum, together with Descriptions of some new Species of Exotic* Iulidæ. By R. I. Pocock.

[Plate XVI.]

Part I.—*Notes upon some Types of Diplopoda.*

Lysiopetalum Hardwickii (Newport), Ann. Mag. Nat. Hist. xiii. p. 267 (1844), is based upon a specimen of *L. fœtidissimum*, Savi, Opusc. Scient. Bologna, i. p. 334 (1817). There appears to be no foundation for the supposition that this specimen came from India.

Lysiopetalum Richii (Gray), in Griffith's Animal Kingdom (Insects, i.), pl. 135. fig. 4, and further characterized by Newport in vol. xiii. of the Annals of Nat. Hist., has been recharacterized by Latzel as *L. anceps* (Myr. Öst.-Ung. Mon. ii. p. 232) and very possibly as *sicanum* by Berlese (Acari, Myr. e Scorp. Ital. pt. vi. no. 7, 1883).

Lysiopetalum rugulosum and *lineatum* of Newport, Ann. & Mag. Nat. Hist. xiii. p. 267, are based upon two specimens specifically identical with each other and with *L. lactarium* of Say; the latter name has the priority.

Iulus niger, Leach, Tr. Linn. Soc. xi. p. 378 (1815) = *I. albipes*, C. Koch, &c.; Leach's name has the priority.

Iulus punctatus, Leach, *loc. cit.* p. 379 (1815) = *I. silvarum*, Meinert, Porath, &c.; not *punctatus*, Meinert, Porath.

Iulus pilosus, Newport, Ann. Nat. Hist. xiii. p. 267 (1844) = *fallax*, Meinert, Nat. Tidskr. (3) v. p. 15 (1868), not *fallax*, Latzel, Haase. This species is Leach's *terrestris* (Linn.), but not the *terrestris* of Linné, Porath, and Stuxberg.

Iulus pilipes, Newport, *loc. cit.* p. 268 (1844) = *I. varius*, Fabr. Spec. Ins. i. p. 528 (1781).

Spirostreptus gracilipes, Newp. *loc. cit.* p. 269, from the Philippine Islands, is based upon a specimen of *Spirobolus*, and has been redescribed as *Spirobolus juloides* by Karsch, Zeitschr. Naturwiss. (3) vi. p. 65.

Spirobolus pulvillatus and *simillimus*, Newport, *loc. cit.* pp. 268, 269, are synonyms; the species has been recharacterized as *giganteus* by Porath, Œfv. Vet.-Ak. Förh. 1872, p. 17, and as *ligulatus* by Voges, Zeitschr. wissen. Zool. 1878, pp. 180, 181.

It is extremely common at Lagos.

Spirobolus caudatus, Newport, *loc. cit.* p. 269, has been redescribed as *P. lætus* by Karsch, Zeitschr. Naturwissen. (3) vi. p. 70.

Spirobolus roseus (Gervais), Ins. Apt. iv. p. 181 (1847), of which a co-type is in the British Museum, has been redescribed as *Sp. costulatus* by Porath, Bih. Sv. Vet.-Akad. Handl. iv. no. 7, p. 31.

Spirostreptus corculus, Butler, Ann. Mag. Nat. Hist. (5) ix. p. 330 (1882), belongs to the same category of species as the other known Madagascar forms. It is based upon young specimens, and may be easily recognized by the two wide longitudinal flavous bands which run throughout the length of the body; the head is flavous, with a conspicuous black band between the eyes.

Loc. Betsileo, Madagascar.

Spirostreptus Cowani, Butler, *loc. cit.* p. 328, is in reality a *Spirobolus* (*cf. infrà*).

Loc. Betsileo (Madagascar).

Spirostreptus avernus, Butler (Ann. Mag. Nat. Hist., June 1876, p. 445), from Rodriguez, is a small, slender, Iuliform species of *Spirobolus*. There are four labral pores on each side; the eyes are separated by a space about equal to three times a diameter; the antennæ are very short; the collum laterally resembles that of a *Spirostreptus*, extending as low as the second tergite. The posterior half of the tergites is elevated and smooth above; the median portion is marked irregularly with crescentic impressions; the pores are situated behind the sulcus on the posterior part of the tergites. Scobina absent. The anal tergite is produced into a triangular tail, which overhangs the valves; valves with margins not compressed.

Sp. globulanus of Karsch, from the Comoro Islands, is very close to this, but appears to differ in the number of labral pores.

Spirostreptus sorornus, Butler (*ibid.*), from Rodriguez, is a *Spirobolus* related apparently to *Goësii* of Porath, but with the median part of the somites scarcely sculptured above and the copulatory feet of a different form.

It is closely allied to *S. comorensis* of Karsch, and to *lumbricinus* of Gerstäcker, both of which have been recorded by Karsch from Mayotte.

Spirostreptus simulans, Butler (*ibid.*), from Rodriguez, is based upon young examples of a species of *Spirobolus*, which will probably prove to be the same as *avernus*.

Spirostreptus Gulliveri, Butler (*ibid.*), from Rodriguez, belongs to the same group as all the Madagascar species. The segments are strongly sulcate, being posteriorly nearly smooth above, but decorated with an obscure anastomosing pattern of low ridges; the anal valves are convex, with their borders uncompressed.

Spirobolus hecate, Butler (*ibid.*), from Rodriguez, is a *Spirostreptus*, allied to all the known Madagascar forms. The posterior part of its somites is thickly punctulate and striolate, and the margins of the anal valves are compressed.

Part II.—*Descriptions of some New Species.*

Spirostreptus stenorhynchus, sp. n. (Pl. XVI. figs. 1–1 *d.*)

Closely allied to *S. Lunelii* of Humbert, of which *kandyanus*, Humb., is probably the young. Both of these have been well figured and described, so that a brief diagnosis of this new form will suffice.

Colour jet-black, shining, and polished, tergites paler in front; lower half of head and antennæ ferruginous, legs clear yellow.

First tergite with a fine anterior sulcus in front of the marginal sulcus; the anterior angle very obtuse in the female, rounded in male, and a little produced. In the anterior half of the body the tergites are dorsally smooth or nearly so, but in the posterior half they are distinctly punctulate and striolate dorsally; the lateral striæ do not in any of the segments unite with the transverse striolæ of the anterior half. The ventral grooves are short, and the sterna are striolate. *Anal somite* as in *Lunelii*. *Legs* with a series of hairs (about 4) on the lower surface of each segment.

Copulatory feet differing from those of *S. Lunelii* in that the anterior lateral lamina bears three teeth, of which the inferior is the longest and the upper the shortest; in *S. Lunelii* the middle one is much longer than the inferior, and the upper one of *S. stenorhynchus* is absent; the protrusible lamina is distally bifid, the external ramus is short, curved, and sublaminate, the internal very long, curled upon itself, and flagelliform.

Loc. Ceylon (*Cuming*); Punduloya (Ceylon), collected and presented by Mr. E. E. Green. Also another example without locality.

Spirobolus erythrocephalus, sp. n. (Pl. XVI. figs. 2–2 *b.*)

Colour. Head, legs, and antennæ blood-red; first tergite almost entirely of the same colour, but with a large black patch on each side above the lateral angle, the two patches connected across the middle line by an ill-defined shadowy fuscous band, which is darker on the middle; the second, third, and fourth tergites black at the sides, blood-red above, with a median black spot; the following tergites in the anterior half of the body similarly coloured, but the dorsal red marks gradually lose their distinctness, becoming first brown, then black; anal somite deep black-brown.

Head smooth and shining, the sulcus distinct below; labral pores obsolete. *Eyes* separated by a space that is about equal to a diameter and a half. *Antennæ* long, much longer than the head.

First tergite projecting inferiorly almost as low as the second, acutely angled, with marginal sulcus, but without other sulci. The rest of the tergites with the posterior portion higher than the anterior, the transverse sulcus complete, the upper surface in front of the sulcus and behind it smooth and polished, the lateral surface thickly and longitudinally striate below, the striæ gradually disappearing above and taking a vertical direction on the anterior part of the tergite; sterna and inferior portion of anterior surface transversely striolate; *pores* conspicuous, above the middle of the side, in front of the sulcus. *Anal somite* nearly smooth, tergite acutely angled behind, covering the summit of the valves; *valves* prominent, the borders strongly convex, almost the posterior half compressed; the sternite large, distinct, and triangular, its angle nearly a right angle.

Legs long, with a single seta beneath each segment, terminal segment padded.

Copulatory feet very wide (see fig. 2 *b*).

Length about 146 millim., width 10.

Number of somites 52.

Loc. N. Madagascar (*Rev. R. Baron*).

Closely allied to *Sp. Cowani* (Butler), from Betsileo. In *Cowani*, however, the anal somite is blood-red, and there is a wide flesh-coloured band along the dorsal surface of the somites. The somites, too, are not so elevated behind and are finely striolate.

Spirobolus urophorus, sp. n. (Pl. XVI. figs. 3, 3 *a*.)

Colour. Head and legs flavous; posterior half and inferior portion of somites also flavous; anterior half fuscous; a median dorsal flavous band more conspicuous posteriorly. Antennæ infuscate.

Body moderately robust, much narrowed posteriorly.

Head smooth, sulcate and striolate above, with two pores on each side of the labrum. *Antennæ* a little longer than the head, the segments, except the first and last, subequal in length. The greatest diameter of the eyes is from above downwards; the distance between them much less than twice this diameter. The collum not projecting so low laterally as the second somite, narrowed laterally, with marginal sulcus, the angle rounded. The rest of the somites laterally striate, the upper surface lightly striolate. The transverse sulcus shallow, the pores immediately in front of it. Scobina absent. *Anal somite* small; tergite produced into a conspicuous, high, compressed, apically upcurled caudal process; *valves* very lightly convex, their margins largely but not deeply compressed; sternite rounded.

Legs moderately slender, the distal segment with many hairs beneath, the rest with only one.

Number of somites 52.

Length about 42 millim., width 4·3.

Loc. Mahé Island, Seychelles (*H.M.S. 'Alert'*).

Spirobolus Naresii, sp. n. (Pl. XVI. figs. 4–4 *b.*)

Closely allied to *Sp. Goësii*, but differing in colour and in the form of the copulatory feet.

Colour. Legs and antennæ flavous and contrasting strongly with the slate-grey tint of the rest of the body; the posterior borders of the tergites ochraceous.

Head, eyes, antennæ, collum, anal somite, pores, &c. as in *Goësii*; the dorsal surface of the posterior portion of the somites much less closely sculptured, with a transverse row of ring-shaped or crescentic impressions just in front of the sulcus.

Number of somites 49–52.

Length up to 40 millim., width 3.

Loc. Mahé Island, Seychelles (*H.M.S. 'Alert'*).

Spirobolus hoplurus, sp. n. (Pl. XVI. figs. 5–5 *b.*)

♂. *Colour* (in alcohol). Head lightly fuscous above, flavous beneath, first tergite and anal somite blood-red, rest of the tergites black in front, with posterior third blood-red; antennæ and legs flavous.

Body slender, parallel-sided.

Head striolate and convex above, flat and smooth below, with two labral pores on each side. *Eyes* separated by a space a little larger than a diameter, with inner border nearly straight, composed of about six transverse rows of ocelli. *Antennæ* about as long as the head.

First tergite smooth, produced laterally considerably below the level of the second, narrowed, the anterior border and angle evenly rounded, with strong marginal sulcus; the posterior angle also rounded, the border above it emarginate. The rest of the somites smooth, polished, the posterior half slightly elevated and separated from the anterior by a shallow groove, very faintly striate below. *Pores* about the middle of the side, just in front of the transverse groove. *Sterna* lightly striate transversely. Without scobina.

Anal tergite produced above into a very long, straight, caudal process, which is wide at the base and narrowed towards the apex; *valves* moderately convex, with their margins deeply compressed above, less deeply below; *sternite* distinct, triangular.

Legs very long, each segment furnished with a single seta beneath, the distal segment padded in front below.

Copulatory feet as in fig. 5 *b*.

Number of somites 48.

Length about 80 millim., width almost 5.

Loc. N.W. Borneo (*R. Everett*). A second example (Borneo, *Lords of the Admiralty*) has 54 somites and measures about 115 millim.

In its slender body, long legs, and produced collum this species superficially resembles a *Spirostreptus*. It is, however, unquestionably a *Spirobolus*, and appears to be a well-marked species, belonging to the same category as *Sp. phranus* of Karsch and *rufo-marginatus* of Tömösvary.

Spirobolus caledonicus, sp. n. (Pl. XVI. figs. 6–6 *b*.)

♂ ♀. *Colour* fusco-olivaceous, with the hinder borders of the tergites ferruginous or flavous; legs rarely narrowly testaceo-annulate, usually black.

Head convex, smooth and shining, the median sulcus widely interrupted in the middle; on each side about five labral pores, of which the three internal are set close together. *Eyes* composed of about twenty ocelli set in six transverse series, with an acute inner angle, separated by a space equal to about twice a diameter. *Antennæ* a little shorter than the head, scarcely reaching to the hinder border of the first tergite.

First tergite smooth above, narrowed laterally, and extending inferiorly as low as the inferior portion of the second, the angle acute but rounded, the anterior edge lightly sinuate but scarcely emarginate, with scarcely a vestige of sulcus. The rest of the tergites without scobina, smooth and polished behind, the anterior (covered) portion being minutely striolate, and the lateral portion just above the base of the legs finely striate; the transverse sulcus almost obsolete, the pores very minute, situated above the middle of the side and just upon the feeble transverse sulcus. *Sterna* striate.

Anal tergite smooth, its posterior border produced into an angle which just overlaps the top of the valves; the *valves* with their borders lightly compressed or convex and without a trace of compression; *sternite* with subcircular hinder border.

Legs with a seta on the lower surface of each segment, male without tarsal pads, the coxæ of the third to fifth pairs a little enlarged.

Copulatory feet as in fig. 6 *b*.

Number of somites 42 (40–44).

Length from 52–73 millim.

A number of examples from New Caledonia.

Very closely allied to *Sp. albidicollis* of Porath, from the same locality, but undoubtedly differing in being smooth and polished instead of coriaceous. The colour, too, is distinct, the collum being by no means largely white.

EXPLANATION OF PLATE XVI.

Fig. 1. *Spirostreptus stenorhynchus*, sp. n.; head and first tergite of male. 1 *a*. Ditto of female. 1 *b*. Anal somite. 1 *c*. Anterior aspect of copulatory apparatus. 1 *d*. Protrusible portion of copulatory apparatus.

Fig. 2. *Spirobolus erythrocephalus*, sp. n.; head and first tergite of male. 2 *a*. Anal somite. 2 *b*. Anterior aspect of copulatory apparatus.

Fig. 3. *Spirobolus urophorus*, sp. n.; head and first tergite. 3 *a*. Anal somite.

Fig. 4. *Spirobolus Naresii*, sp. n.; head and first tergite. 4 *a*. Anal somite. 4 *b*. Anterior aspect of copulatory apparatus.

Fig. 5. *Spirobolus hoplurus*, sp. n.; head and first tergite. 5 *a*. Anal somite. 5 *b*. Anterior aspect of copulatory apparatus.

Fig. 6. *Spirobolus caledonicus*, sp. n.; head and first tergite. 6 *a*. Anal somite. 6 *b*. Anterior aspect of copulatory apparatus.

N.B.—All the figures are enlarged.

XLIV.—*Descriptions of some new Genera and Species of Longicorn Coleoptera.* By C. J. Gahan, M.A., of the British Museum (Natural History).

The genera and species described in this paper are all from Asia.

Philus costatus, sp. n.

Flavo-testaceus; prothorace quam longiore sesqui-latiore, dorso crebre punctulato, lateribus subrotundatis, postice sat distincte carinatis elytris crebre punctulatis, utrisque costis quatuor paullo elevatis, quarum duabus internis distinctioribus, obtectis; articulis antennarum a tertio ad decimum subæqualibus, apice intus angulatis.

♂. Antennis quam corpore longioribus; femoribus subtus longitudinaliter canaliculatis, canaliculis pilosis.

♀. Antennis medium elytrorum haud superantibus; femoribus subtus versus apicem subplanatis, vix canaliculatis.

Long., ♂ 20, ♀ 22–25 millim.

Hab. Siam (*J. C. Bowring*).

Head thickly punctured, with the punctures somewhat coarser towards the occiput; the front divided by a median longitudinal groove, and separated from the clypeus by a rather deep transversely arcuate groove. Prothorax densely but feebly punctured, with a very narrow space along the middle, which is smooth, nitid, and impressed with a faint line; sides distinctly carinate in an oblique direction on their posterior half, the carina becoming obsolete in front of the middle. Scutellum and sides of mesonotum rather thickly punctured. Elytra closely punctulate, each with three or four raised lines or costæ, of which the two innermost are usually very distinct and unite posteriorly, to be continued a little further back as a single line; the third costa is less distinct, and a little before the apex bends in to join the posterior end of the common stem of the two inner costæ; the fourth line is still less distinct and is sometimes almost quite obsolete. A very faint pubescence, consisting of very short suberect fulvous hairs, is present over all parts of the body.

PARAPHILUS, gen. nov.

Allied to *Vesperus*, but differing from that genus by the following characters:—Head shorter, gradually narrowed from the eyes backwards, and without a distinct constriction or neck. Prothorax slightly rounded at the sides, and scarcely narrower anteriorly than at the base, its lower front margin not deeply emarginate; prosternal process somewhat wider, so that the anterior coxæ are less approximated. First abdominal sternite of the female more sharply pointed in front. Third joint of the tarsi less deeply cleft.

The great resemblance which the unique species of this genus presents to some of the species of *Philus* is further evidence in favour of the view that *Vesperus* is nearly related to, and should be placed near, the Monodesmid group of Prionidæ.

Paraphilus duplex, sp. n.

Testaceus, fulvo tenuissime pubescens; elytris pallidioribus; prothorace paullo transverso, supra subnitido, sat dense minuteque punctulato; elytris erebro punctulatis, pallidis, versus basin subnitidis testaceis, (♂) apicem abdominis paullo superantibus, (♀) segmentum primum abdominis ventrale vix excedentibus.

Long. ♂ 17–21 millim.

Hab. China: Pekin (*Swinhoe*); Foochow (*J. de la Touche*).

Head dull reddish testaceous, closely and minutely punctured. Prothorax somewhat nitid above, minutely and rather densely punctured, the sides slightly rounded in the middle, and without any trace of a lateral carina. Elytra in the male completely covering the abdomen, closely punctulate, pale yellowish testaceous in colour, with the base more reddish and slightly nitid, each narrowed and subacuminate at the apex; in the female scarcely reaching beyond the second ventral segment of the abdomen, dehiscent at the suture, each rounded at the apex.

Antennæ of the male a little longer than the body, first joint short, third to tenth subequal to one another, each nearly three times as long as the first, the eleventh a little longer than the tenth; the joints from the third are all slightly flattened and are a little thickened, but scarcely angulate at their distal ends. The antennæ of the female extend beyond the apex of the elytra, but do not reach to the tip of the abdomen, and, besides being shorter, are slenderer than in the male.

PSEUDOPHILUS, gen. nov.

Head strongly exserted, with the upper side oblique, and slightly depressed between the eyes; front rather short, subvertical, with its upper portion longitudinally impressed in the middle, its lower part with a somewhat elliptical impression circumscribing a narrow transverse area. Mandibles and palpi of moderate length. Inner border of each of the antennary condyles forming a slightly projecting process above. Antennæ of the male about equal in length to the body; first joint slightly curved, thickened towards its apex, third joint scarcely longer than the first, the fourth much shorter, the fifth distinctly longer than the fourth, the sixth to eleventh gradually increasing in length. Antennæ of the female reaching to very little beyond the middle of the elytra. Eyes coarsely faceted, emarginate, with the lower lobes rather large. Prothorax slightly constricted and transversely impressed near the base and apex, with its sides slightly rounded in the middle; its greatest breadth about equal to its median length. Scutellum somewhat concave from side to side; the anterior part of the mesonotum, which is separated from the scutellum by a transverse groove, has no stridulating surface, but bears instead an impressed line along the middle, on each side of which it is rather coarsely and thickly punctured. The elytra, which are a good deal broader than, and about three and a half times as long as, the prothorax, are rounded at the apex. The anterior cotyloid cavities are angulate externally and are somewhat open behind. The legs, which slightly increase in length from the anterior to the posterior, have the femora somewhat compressed and broader towards the middle of their length.

This genus seems to me to be best placed in the group of the Hesperophanides, of which it possesses all the most essential characters. It has some resemblance in general appearance to the Prionid genus *Philus*, and, like the Prionidæ in general, it is without a stridulating surface to the mesonotum.

Pseudophilus testaceus, sp. n.

Brunneo-testaceus, fulvo sparse erecteque setosus; capite dense punctato; prothorace subrugoso-punctato, disco nonnihil leviore, linea media elevata plus minusve distincta; elytris fulvo tenuissime pubescentibus et sparse setosis.

Long. 27-31 millim.

Hab. Valley of the Tigris and Euphrates.

Prothorax rather strongly and somewhat rugosely punctured at the sides; the disk sometimes rather smooth, especially posteriorly, and provided with a median, slightly elevated line or carina, which in some examples is almost obsolete. The elytra each bear one or two feeble or almost obsolete longitudinal costæ, and are furnished with small punctures of two kinds:—1st, the very minute pits from which the short hairs of the pubescence arise, and, 2nd, the somewhat larger and sparser pits from which the longer setæ spring; they are of a testaceous colour, somewhat darker towards the base.

The female of this species, which was taken at Fao, on the Persian Gulf, has been presented to the Museum by Mr. W. D. Cumming; for the male, taken at Bussorah, I am indebted to the liberality of Mr. R. Wylie Lloyd. A much damaged specimen, which has long been in the Museum collection, was brought from near the ruins of Nineveh.

Niphona tibialis, sp. n.

N. cylindraceæ similis, sed prothorace lateraliter minus valde dentato, tibiis intermediis (♂) versus apicem intus crassatis et valde spinosis.

Long. 22 millim.

Hab. Canara, South India (*Bell*).

Pubescence greyish, with a number of small scattered rust-coloured spots. Prothorax rather darker than the rest of the upperside, with two short feeble ridges running close together along the middle of the disk, and, external to these, two or three small tubercles on each side of the disk. There is a rather small but distinct tooth low down on each side a little behind the anterior margin of the prothorax, and a larger blunter tooth or tubercle higher up and nearer to the middle. The elytra are thickly and strongly punctured, though the punctures are to some extent obscured by the close pubescence; each has at the base a few small tufts of dark brown hairs, and, just below the shoulder, two very short dark brown vittæ; a pubescence of a paler grey forms two somewhat irregular and ill-defined bands crossing the elytra, one before, the other behind, the middle. In the male the fifth abdominal sternite has a peculiar form; the posterior half is marked by two grooves, which divide off two lateral portions from a median portion; the median part is flattened, and is transversely truncate behind; the lateral portions are slightly curved downwards, and are produced behind into two processes, which arch over and meet in the middle line. The second abdominal segment has a narrow transverse depression on each side anteriorly, which is covered over by the fringe of fulvous hairs attached to the hind margin of the first segment. The anterior tibiæ of the male are strongly bent inwards from about the middle of their length, and each bears a spine on the inner side between the middle and apex; the tibiæ of the middle pair are strongly bent inwards towards their apex, and each has a strong sharp spine placed on the inner side of this somewhat thickened apical portion. The trochanters of the middle pair are also produced into a small spine at their extremities.

This species has a great resemblance to *Niphona cylindracea*, White; but the latter is more strongly toothed on the side of the prothorax, its middle tibiæ in the male are not bent in strongly at the apex, and are not spined, nor are the trochanters of the same pair spinose at their extremities; the lateral processes of the last ventral segment of the male are also shorter, and in those examples that I have seen are not curved downwards towards the middle line.

ALIDUS, gen. nov. (*Niphonidæ*).

Prothorax angulate or feebly tuberculate at the middle of each side. Mesonotum without stridulating surface, but with a smooth polished line along the middle. Prosternal and mesosternal processes with their opposed faces subvertical, both processes transversely rugulose and longitudinally canaliculate; the horizontal face of the prosternal process somewhat dilated posteriorly to fit into corresponding depressions on the sides of the coxæ. Eyes rather small, subdivided. Antennæ of the male nearly one half longer than the body; those of the female about equal in length to the body; first and third joints subequal in length, the fifth longer and slightly curved, each of the succeeding joints, the eleventh excepted, subequal to or slightly shorter than the third.

This genus may be recognized by the rather exceptional character, for this group, which it possesses in having the sides of the prothorax tuberculate in the middle.

Alidus biplagiatus, sp. n.

Dilute fuscus, maculis punctisque flavo-albidis sparsim aspersis, prothoracis dorso plaga ovali fusco-velutina utrinque ornato.
Long. 23–25, lat. 9–11 millim.

Hab. China (*J. C. Bowring*) and Assam (*Atkinson*).

Dark brown, with darker brown points and numerous minute scattered yellowish-white points and spots, the most conspicuous of which are a spot on the base of the fourth antennal joint, a small patch on the middle of each tibia, and a few spots forming a narrow zigzag band between the middle and posterior thirds of each elytron. Prothorax with a large oval dark brown velvety area on each side of the disk, which is bounded by a narrow pale yellowish margin. The elytra are furnished with some sparsely scattered granules towards the base, and with some sparse punctures, each of which is marked in position by a small dark spot.

This species may be easily recognized by the two large oval and dark brown velvety areas on the pronotum.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

December 21, 1892.—Prof. J. W. Judd, F.R.S.,
Vice-President, in the Chair.

The following communications were read:—

1. "On a Sauropodous Dinosaurian Vertebra from the Wealden of Hastings." By R. Lydekker, Esq., B.A., F.G.S.

In addition to *Hoplosaurus armatus* and *Pelerosaurus Conybearei*, there is evidence of another large Sauropodous Dinosaur in the Wealden, now known as *Morosaurus brevis.* Up to the present time it has been impossible adequately to compare *Hoplosaurus armatus* with *Morosaurus brevis*; but recently Mr. Rufford has sent to the British Museum an imperfect dorsal vertebra of a large Sauropodous Dinosaur from the Wealden of Hastings, which enabled the required comparison to be made. The Author describes the vertebra, contrasts it with that of *Hoplosaurus armatus*, and gives presumptive evidence that it should be referred to the so-called *Morosaurus Becklesi* (Marsh), which apparently cannot be separated from *M.* (*Cetiosaurus*) *brevis.* He has not been able to compare Mr. Rufford's specimen with the dorsals of the American *Morosaurus*, in order to discover whether the English Dinosaur is correctly referred to that genus.

2. "On some additional Remains of Cestraciont and other Fishes in the Green Gritty Marls, immediately overlying the Red Marls of the Upper Keuper in Warwickshire." By the Rev. P. B. Brodie, M.A.

The vertebrate remains occur in a very thin band of marly friable sandstone lying between two beds of green marl, though in some places the same bed has itself no admixture of sandy material. Bones and teeth are so numerous that it might almost be called a bone-bed. It does not exceed three inches in thickness. It contains ichthyodorulites of Cestraciont fishes, abundant palatal teeth of *Acrodus keuperinus*, ganoid fish-scales, and abundant broken bones, some of which may belong to fishes, others to labyrinthodonts, and amongst the latter a fragment of a cranial bone.

3. "*Calamostachys Binneyana*, Schimp." By Thomas Hick, Esq., B.A., B.Sc. Communicated by J. W. Davis, Esq., F.G.S., F.L.S.

A number of preparations lately placed in the hands of the Author by Mr. W. Cash, of Halifax, give much additional information on many important points of detail connected with the structure and characters of the sporiferous spike known as *Calamostachys Binneyana*, and also throw considerable light on the question of its affinities. The Author fully describes the structure of the fossil, and discusses its systematic position. His description shows the close resemblance between the structure of this spike and that of *Equisetum*; and it is noted that Carruthers, in 1867, did not hesitate to describe *Calamostachys Binneyana* as the fruit of *Calamites*, and that Binney, when making it the fruit of *Calamodendron commune*, was in practical agreement with Carruthers. Williamson, however, realizing the difficulty of reconciling the supposed vascular central part of the axis of the spike with a Calamitean affinity, suggested that the relationship lies rather with the Lycopodiaceæ. Now the establishment in the present paper of the existence of parenchymatous pith in the axis of the spike removes the chief ground for Williamson's suggestion; and the demonstration of the existence of primary vascular bundles with carinal canals affords positive proof of the closeness of its relationship with the Calamitæ. The Author gives reasons for concluding that there is much probability that the fossil described in the paper is a spike of a *Calamites* of the type of *Arthropitys*.

4. "Notes on some Pennsylvanian Calamites." By W. S. Gresley, Esq., F.G.S.

The Author believes that a group of specimens from the Pottsville conglomerate series demonstrates that the so-called Calamite-casts in sandstone are not always to be regarded as casts of pith-cavity only, but are often casts of the vascular cylinder as well; also that these specimens show that some Calamites, at all events, possessed furrowed exteriors or barks. A specimen from the Pittston bed of anthracite in the Wyoming basin also seems to suggest that the true bark had not always a smooth exterior.

A specimen from the same geological horizon as the last specimen, and from a neighbouring locality, indicates a Calamite of gigantic proportions. Another specimen, from the Pittsburgh bed, is remarkable as showing two branch-scars not on, but below the nodes of the Calamite.

MISCELLANEOUS.

The Dates of Moore's 'Lepidoptera Indica.'

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

Gentlemen,—The extreme importance of the exact dating of publications which contain new generic or specific names is now so generally recognized that no apology is needed for bringing before the notice of your readers a particularly gross case, whereby the author eventually obtains six months or more priority over other writers. The foolish practice of throwing away the wrappers of separately published parts of a serial work, instead of binding them up *in place exactly as issued*, is so common that those who pre-date their publications are invariably assisted in their deception. Fortunately in the Natural-History Museum a sharp look-out is kept for cases of this kind, and covers are always considered when a book is sent to the binders.

The book that I wish to call attention to is F. Moore's 'Lepidoptera Indica,' of which thirteen parts have already appeared, and of which the proper dates are the following:—

Pt. 1.	pp. i–viii, 1–24,	April **1890**.	
2.	„ 25–56,	June **1890**.	
3.	„ 57–80,	Sept. **1890**.	
4.	„ 81–96,	Nov. **1890**.	
5.	„ 97–112,	Dec. **1890**.	
6.	„ 113–128,	Feb. **1891**.	*Not Aug.* 1890, *as stated in the signatures!*
7.	„ 129–152,	Aug. **1891**.	*Not Aug. and Nov.* 1890 *and July* 1891, *as stated in the signatures!*
8.	„ 153–176,	Oct. **1891**.	*Not July* 1891, *as stated in the signatures!*
9.	„ 177–208,	Jan. **1892**.	*Not Aug. and Sept.* 1891, *as stated in the signatures!*
10.	„ 209–240,	April **1892**.	*Not Oct.* 1891 *and Jan.* 1892, *as stated in the signatures!*
11.	„ 241-272,	Sept. **1892**.	*Not Jan., Mar., and Apr.* 1892, *as stated in the signatures!*
12.	„ 273-310,	Dec. **1892**.	*Not May and June* 1892, *as stated in the signatures!*
13.	„ 1–32,	Jan. **1893**.	*Not Aug.* 1892, *as stated in the signatures!*

I do not know whether the author or the publisher is responsible for this deceptive dating; but it is to be hoped that neither Mr. Lovell Reeve nor Mr. Moore will any further indulge in such objectionable vagaries.

C. Davies Sherborn
(Index gen. et spec. anim.).

Natural-History Museum,
Cromwell Road, S.W.
Feb. 18, 1893.

Diffuse Pigmentation of the Epidermis of the Oyster due to prolonged exposure to the light: Regeneration of Shell and Loss of Adductor Muscle.

Prof. Ryder reported on behalf of Prof. R. C. Schiedt that oysters which had the right valve removed and exposed to the light in this condition, in a living state, for a fortnight or so, developed pigment over the whole of the epidermis of the exposed right mantle and on the upper exposed sides of the gills, so that the whole animal from this cause assumed a dark-brown colour. Animals so exposed not only attempted to reproduce the lost valve and hinge, but also partly succeeded in so doing, even re-establishing the insertion of the diminutive pedal muscle upon the inner face of the imperfectly reproduced right valve, which was deformed owing to the lack of support of the right mantle, because of the removal of the original right valve. As a consequence the right mantle was rolled up at the edge, and this deformation of the mantle was reflected in the attempted regeneration of the lost right valve. The pigment developed during exposure to light in the mantle and gills in oysters with the right valve removed which were kept alive in the aquaria at Sea Isle City by Prof. Schiedt was wholly confined to the epidermis as it normally is at the mantle-border in the unmutilated animal in nature. The inference to be drawn from these facts is that the development of pigment in the mantle and gills was wholly and directly due to the abnormal and general stimulus of light over the exposed surface of the mantle and gills, due to removal of the right valve, and that the mantle-border, the only pigmented portion of the animal, is pigmented because it is the only portion of the animal which is normally and constantly subjected to the stimulus of light.

Oysters which had the right valve removed were found to live perfectly well in the marine aquaria at Sea Isle, and would no doubt have survived till now had Prof. Schiedt been able to continue his experiments there. The most remarkable results obtained as a consequence of these experiments were that the adductor muscle was soon attacked by bacteria and destroyed by putrefaction, while the great ganglion underlying it remained uninjured. The pericardiac cavity was also torn open, exposing the heart completely, in some instances. In these cases the heart continued to beat and propel the blood through the other organs of the body as if nothing untoward had happened. The maximum rate of pulsation of the heart noted was 52 per minute, which is much greater than the rate hitherto reported.

The anus was also retracted into a new and more anterior position, owing to the loss of support which it had suffered in consequence of the sloughing away of the adductor muscle. Whether the adductor muscle thus sloughed away would ultimately be reproduced was not determined, since the experiments were interrupted before the animals had time to present evidence of such regeneration of the lost muscles.

These experiments open up a most suggestive line of investigation upon other univalve and bivalve mollusca, viz.: experimental researches as to the effect of removing the valves and exposing them to the light. Many other species, both marine and freshwater, might obviously be experimented upon with very instructive results as respects the questions raised by the present communication.—*Proc. Acad. Nat. Sci. Philad.* Nov. 15, 1892.

The Hermaphroditism and Viviparity of the Oysters of the North-west coast of the United States.

Prof. J. A. Ryder also reported on behalf of Prof. R. C. Schiedt, of Franklin and Marshall College, Lancaster, Pa., the latter's discovery of the fact that the oysters native to the north-west coast of the United States are hermaphrodite and viviparous. Specimens from the coast of Oregon and Washington show that the same condition exists in the reproductive follicles as in those of *Ostrea edulis* of Europe. The presence of eggs and of spermatoblasts and spermatozoa in the same follicles is the invariable rule. The ova, like those of *O. edulis*, are much larger than those of *O. virginica*, though perhaps not quite so large as the former. The embryos are fertilized in the gill and mantle cavities, where they undergo development.

These north-west-coast oysters also resemble the oysters of Europe in that they are small and have little or no indication of purple pigment on the impression or point of insertion of the adductor muscle, which is so conspicuous a feature in *Ostrea virginica* of our eastern coast.—*Proc. Acad. Nat. Sci. Philad.* Nov. 15, 1892.

Large Variations in the Metamorphosis of the same Species.

An elaborate memoir entitled, "The Embryology and Metamorphosis of the Macroura," by W. K. Brooks and F. H. Herrick, makes 140 pages quarto of the fifth volume of the Memoirs of the U. S. National Academy of Sciences, and is illustrated by 57 plates. The species microscopically investigated and here reported upon are of the genera *Gonodactylus*, *Alpheus*, and *Stenopus*. The authors mention, in the introductory pages, as one remarkable result of their study of the genus *Alpheus*, the discovery that while the larval stages of different species are similar, the individuals of a single species sometimes differ more from each other as regards their metamorphoses than the individuals of two very distinct species, and make on this point the following remarks:—

This phenomenon has been observed by us and carefully studied in two species—*Alpheus heterochelis* and *Alpheus Saulcyi*—and it is described in detail, with ample illustrations, in the chapter on the metamorphosis of *Alpheus*. In the case of the first species the difference seems to be geographical, for while all the individuals which live in the same locality pass through the same series of larval stages, the life-history of those which are found at Key West is very different from that of those which live on the coast of North Carolina, while those which we studied in the Bahama Islands present still another life-history. In the case of the second species —*Alpheus Saulcyi*—the difference stands in direct relation to the conditions of life. The individuals of this species inhabit the tubes and chambers of two species of sponges which are often found growing on the same reef, and the metamorphosis of those which live in one of these sponges is sometimes different from that of those which inhabit the other. In this species the adults also are different from each other, but as we found a perfect series of transitional forms there is no good reason for regarding them as specifically distinct; and in the case of the other species—*Alpheus heterochelis*—we were unable, after the most thorough and minute comparison, to find any difference whatever between adults from North Carolina and those from the Bahama Islands, although their life-histories exhibit a most surprising lack of agreement. In fact, the early stages in the life of *Alpheus heterochelis* in the Bahama Islands differ much less from those of *Alpheus minor* or *Alpheus Normani* than they do from those of the North Carolina *Alpheus heterochelis*; and, according to Packard, the Key West *heterochelis* presents still another life-history.

In the summer of 1881 I received the 'American Naturalist' with Packard's very brief abstract of his observations at Key West upon the development of *Alpheus heterochelis*, and read with great surprise his statement that this species has no metamorphosis, since, while still inside the egg, it has all the essential characteristics of the adult. As I had under my microscope at Beaufort on the very day when I read his account a newly hatched larva of the same species and was engaged in making drawings to illustrate the metamorphosis of which he denies the existence, and as my experience in the study of other Crustacea had taught me that all the larvæ of a species at the same age are apparently facsimiles of each other down to the smallest hair, Packard's account seemed absolutely incredible, and I hastily decided that, inasmuch as it was without illustrations and was written from notes made many years before, it involved some serious error and was unworthy of acceptance. This hasty verdict I now believe to have been unjust, since my wider acquaintance with the genus has brought to my notice other instances of equally great diversity between the larvæ of different specimens of a single species.

The phenomenon is, however, a highly remarkable one and worthy the most thorough examination, for it is a most surprising departure from one of the established laws of embryology—the law that the embryonic and larval stages of animals best exhibit their fundamental affinities and general resemblances, while their specific characteristics and individual peculiarities make their appearance later.—*Am. Journ. Sci.*, Feb. 1893, pp. 166, 167.

Absorption in the Actiniæ *and the Origin of the Mesenterial Filaments.* By Victor Willem, Assistant in Zoology at the University of Ghent.

If albumen stained with carmine is administered to specimens of *Actinia* or *Sagartia* it is found that at the end of a few hours particles of carmine are present in the cells of the lining of the enteric cavity. Properly speaking this absorption does not take place in the enteroids, as is stated by Krukenberg * and Metschnikoff †, but at first and chiefly in the region of the radial partitions which adjoins these filaments, a region where the epithelium forms a thickening parallel with the edge of the septum ‡; the grains of

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* Krukenberg, "Ueber den Verdauungsmodus der Actinien," Vergl.-phys. Studien an der Küste der Adria, 1 Abth., 1880.

† Metschnikoff, "Ueber die intracellulare Verdauung bei Cœlenteraten," Zool. Anz. 1880, p. 261.

‡ *Vide* Hertwig, "Die Actinien," Jenaische Zeitschrift, 1879, Taf. xxi. fig. 13.

carmine are again met with in the cells of the grooves which separate either the lateral ciliated bands from the median band which is provided with nematocysts, or the lateral bands from one another *.

If nutriment tinctured with carmine is supplied in great abundance, not only does the red coloration become more intense in the regions which have just been indicated, but we also find grains of carmine in large numbers in the cells of the whole endodermic lining. In *Sagartia* again, contrary to the assertion of Metschnikoff, these may be easily observed in the acontia, throughout the entire zone which is devoid of nematocysts and gland-cells †.

Moreover, identical results are obtained by using mussel's liver; the yellowish-brown coloration of the fatty globules contained in the cells of this organ enables us to recognize the same progression in the absorption of these droplets. The examination of sections of *Actiniæ* which have been fed abundantly upon the fat-body of caterpillars shows, in the cells of the entire endodermic lining and in those of the regions of the mesenterial filaments or of the acontia which I have indicated above ‡, the presence of numerous fatty droplets, which are often of enormous size relatively to the dimensions of the elements which contain them.

In the numerous fresh or prepared specimens which I have examined I have never seen a particle of carmine or a fatty globule in a cell of one of the three swellings which enter into the composition of a typical mesenterial filament.

Absorption therefore belongs in itself to the whole of the endodermic lining, and if (as, for instance, when the animals were supplied with nutriment stained with carmine) it appears to be more evident in certain parts of the enteroids and in their neighbourhood, this is due to two causes: in the first place to the fact that the zones in question, being closer to the spot § at which the disaggregation of the ingested matters takes place, capture the grains of carmine as soon as they are set at liberty by the dissolution of their substratum; those only which penetrate into the radial divisions are absorbed by the general lining. In the second place it is due to the existence along the enteroids of a thickening in which the more elevated cells accumulate more of the carmine particles.

The localization of the absorbent cells brings out an important point in the disposition of the different tissues in the *Actiniæ*, which is in relation to their nutrition and the absence of an actual circulatory system. All the regions of the body, of however little extent, include cells in which there takes place an intra-cellular digestion and the elaboration of the assimilable substances which are destined for the elements in the immediate neighbourhood: the outer wall, including the tentacles and the stomodæum itself, is clothed with an endodermic lining; the swellings of the enteroids are separated by bands of absorbent cells, while the acontia exhibit on one of their

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* *Ibid.* Taf. xxi. figs. 10 and 14.

† *Ibid.* Taf. xvi. fig. 11.

‡ These are shown in the Hertwigs' figures as constituted by a granular epithelium.

§ The central region of the general cavity.

faces a zone which may be termed the nutritive zone of the acontium; in the immediate neighbourhood of the mesenterial filaments —at the spot where the median swelling alone persists—the epithelium of the septa exhibits a special development, which seems to me to be in direct relation to the nutrition of these organs of secretion.

These physiological facts appear to me to contribute towards clearing up the origin of the convoluted filaments in ontogeny. Heider[*], relying on the identity of their histological structure, admitted the ectodermic origin of the enteroids in *Cerianthus*, and E. B. Wilson[†] considered it to be very probable that the lateral lobes are the homologues of the ectodermic bands of the Alcyonaria, while in his opinion the central lobe is of an endodermic nature. A. Andres[‡] thought that he had succeeded in deriving certain filaments of the Actiniaria from ectodermic proliferations of the stomodæum. But it seems to follow, from certain observations of H. V. Wilson[§], that this ectodermic origin ought to be attributed not only to the lateral lobes, but also to the median one, at the very least in the case of the primary mesenteries.

However it may be with regard to supposing, as appears to me to be very probable, that the three lobes composing a typical filament are of an ectodermic nature, it is not less probable that, relying on the identity in histological structure and physiological function, we ought to consider as **endodermic the regions of the filaments which separate the lobes from one another and the nutritive zone of the acontia.**—*Zoologischer Anzeiger,* xvi. Jahrg., no. 409 (January 9, 1893), pp. 10–12.

On Phagocytosis observed, in the living Animal, in the Gills of Lamellibranch Mollusca[‖]. By M. de Bruyne.

In a communication of Nov. 3, 1891 ('Annales de la Faculté de Médecine de Gand'), I mentioned incidentally some phenomena of phagocytosis which had been observed in the normal ciliated epithelium of the gills and mantle of Lamellibranch Mollusks; these observations related exclusively to fixed preparations. Since then I have studied the phenomenon in the living animal, by operating upon four very common forms—*Mytilus*, *Unio,* and *Anodonta*, which are very suitable for this kind of observation, and *Ostrea,* which is much less so, probably on account of the thickness of its gills.

If a fragment of gill be removed from a freshly opened specimen of one of these animals (*Mytilus* by preference), and examined under the microscope, the observer is struck by the clearness with

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[*] V. Heider, "*Cerianthus membranaceus,*" Sitzgsber. Akad. Wiss. Wien, Bd. lxxix. (1879).

[†] E. B. Wilson, "The Mesenterial Filaments of the Alcyonaria," Mittheil. zool. Stat. Neapel, Bd. v. (1884).

[‡] A. Andres, quoted in the foregoing paper.

[§] H. V. Wilson, "The Development of *Manicina areolata,*" Journal of Morphology, 1889.

[‖] The investigations were conducted at the Laboratory of Normal Histology of the University of Ghent.

which all the structural details are seen. I have obtained the best results by using Zeiss' No. 4 eyepiece and F objective (magnifying-power 1010). Under these conditions the globules of the blood appear as little amœboid corpuscules with very distinct nuclei. Their protoplasm is sometimes perfectly hyaline, with a few scattered granulations which exhibit an active Brownian movement; sometimes finely granular; or again packed with hyaline globes of variable dimensions, which may or may not contain in their turn some very refringent spheres. The pseudopodia, which may be seen to appear and disappear, are either numerous and delicate, always perfectly hyaline and extended in all directions, or else on the contrary isolated, broad, and true lobopodia. It is possible to follow the blood-corpuscles in their peregrinations; in this way, on the confines of the epithelium, one of these migratory cells is often seen to leave the connective tissue and penetrate between the ciliated cells, separating and depressing them, and thus producing behind it a solution of continuity which goes on increasing. But we soon find that it is something more than a simple separation or depression: the actual substance of the cells is broken into, and exhibits unequivocal signs of alteration. The protoplasm diminishes in places and appears to be eaten away at spots where it has been in contact with a leucocyte. In no case was I able to discover that the amœboid globule here contained fragments of epithelial cells. The question arises whether we have to deal with digestion at the surface of the leucocyte, or at least with dissolution preparatory to digestion. However this may be, a cavity is thus produced which is hollowed out by the leucocytes at the expense of the epithelium. This cavity continues to increase in size, and soon extends to several neighbouring cells; it has very distinct limits, which are sometimes exceedingly irregular, and successively assumes the most varied shapes.

Since it most often happens that the same phenomenon takes place at adjoining spots, the result frequently is that the last remaining cells which still separate the cavities disappear in their turn by the same process; extensive lacunæ are thus formed by means of fusion, in which there move a larger or smaller number of leucocytes, each of which acts as a phagocyte on its own account *. The free portion of the ciliated cells is most often intact, and there always persists a border constituted by the fragments of protoplasm which have escaped from the devastation. The body of the phagocytes grows considerably, in most cases becomes packed with hyaline spheres, and continues to move freely in the lacuna. Here and there they finally cross the border itself at some spot or other, and leave the lacuna to reach the surface of the branchial mucous membrane; where they are speedily carried away by the current which is produced in the water by the motion of the vibratile cilia.

The very interesting phenomenon which I have just described, and which, so far as I am aware, has not hitherto been recorded,

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* In these lacunæ it is also not unusual to meet with one or more leucocytes which have come from the depths, and are charged with matter of a yellow or dirty brown colour.

is in the living animal usually observed only in the epithelium of the lower (free) border of the gills (it also occurs pretty frequently in the buccal tentacles); but in most cases, over the entire extent of the epithelium, it is possible to witness the penetration of blood-corpuscles, which come from the lacunar connective tissue and are charged with granulations or hyaline spheres of variable, and sometimes very considerable, dimensions. They advance slowly, thrusting out pseudopodia between the epithelial cells, and thus opening a path for themselves to the free surface, where they undergo the same fate as those which leave the lacunæ: *i. e.* they are carried away by the current. The presence of phagocytes among the epithelial cells has recently been mentioned by Dr. Janssens ('La Cellule,' t. ix.).

It may be asked what is the physiological object of this phenomenon. Without pretending to solve the question at present, and reserving to myself the right of reverting to it at greater length, I wish to point out one way of looking at it. In preparations fixed by means of Flemming's or Hermann's fluid, I have often discovered, either in the phagocytes, or in the tissues, the presence of degenerate leucocytes. They appeared in the most varied shapes; but they were always composed of a sphere or of an irregular body, but little or not at all stainable, and serving as a substratum for one or more corpuscles which took a decided saffron stain: the substratum was of protoplasmic origin, the chromatic element was derived from the nucleus. In the same way in the phagocytes, the spheres, which were hyaline in the fresh state, seemed, from their low degree of colourability, to be composed of more or less altered protoplasm. Given these details, the question arises whether it would not be possible to find in the present case an application of the views of Metschnikoff and others, on the subject of a continual strife between the cells of the same organism, which results in the sweeping of the tissues, and in the removal of anatomical elements which are enfeebled, sickly, or decaying, by means of amœboid cells still in the full vigour of active life. The phagocytes which have come from the depths and contain spheres or coloured matters would have loaded themselves with fæces and dead cells, met with in their diapedeses, and would transport them to the exterior through the epithelium; on the other hand, the migratory elements which hollow out the epithelium would have been summoned thither by chemiotaxy: the vibratile cells of the lower border of the gill-lamellæ are, by their very position, more than all the others exposed to all kinds of destructive influences; as a consequence they would rapidly become worn out and enfeebled, and their debilitated bodies would attract the leucocytes.

N.B.—The way in which the tissues thus injured are renewed still remains to be examined; this will form the subject of investigations to which I intend to devote myself later on. In conclusion, I do not think it necessary to dwell upon the fact that the lacunæ, which have been mentioned so often in the present communication, cannot be confounded with the lattice-like clefts, which permit the passage of the water into the interbranchial spaces.—*Comptes Rendus*, t. cxvi. no. 2 (Jan. 9, 1893), pp. 65–68.

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XLV.—*Preliminary Account of the Freshwater Medusa of Lake Tanganyika.* By R. T. GÜNTHER, B.A.

[Plates XIII. & XIV.]

IN August 1891 Mr. F. L. M. Moir, Manager of the African Lakes Company, informed Dr. A. Günther that he had observed Medusæ in large numbers in one of the bays of Lake Tanganyika. "They were about ¾ of an inch in diameter, and their rounded top was so clear as to give the idea they were merely circular bodies and not the shape of an ordinary Medusa; the more opaque ovaries gave this appearance." At the same time Mr. Moir kindly undertook to obtain specimens properly prepared with osmic acid; and, thanks to the assistance of Mr. A. J. Swann, these specimens arrived in good condition at the end of last year. This material was placed by my father in my hands for examination and description.

Although Mr. Moir has thus the merit of having been the first to succeed in having specimens brought to Europe, he is not the original discoverer of the species. In fact, from April and during our summer months the Medusæ seem to be exceedingly abundant about the bays of the lake, so much so, that they attract the notice of all visitors.

In December 1883 Professor E. von Martens[*] communi-

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[*] Sitzgsb. naturf. Fr. Berl. 1883, p. 197.

cated to the 'Gesellschaft naturforschender Freunde zu Berlin' the substance of a letter from Dr. R. Böhm, then travelling in Africa, relating to the discovery of a Craspedote Medusa in Lake Tanganyika. The information to be gathered from Böhm's account was restricted to the following points:—that the Medusa was provided with a velum; that it had a small short broad stomach, at the base of which the genital organs are situated; and, finally, that the tentacles were very numerous and of unequal length. On account of the complete physical isolation of Lake Tanganyika from all other localities from which Medusæ are known, Böhm very justly considered the newly discovered species to be unknown to science, and accordingly proposed the specific name of *tanganjicæ*, leaving the generic name, and at the same time deploring that the absence of all necessary literature prevented him from further determining the zoological position of the species.

Evidently the same animal has since been observed by H. von Wissmann, who, when describing his passage across the lake on the 13th of April, 1887*, says, "I was greatly astonished to observe a number of sea-nettles surround our boat for about half an hour. They were transparent, of the shape of a disk, and like a mark-piece in size; round the edge was a milky circle, hanging down in fibres, by means of which they swam."

Such, then, are the sole facts which, so far as I know, have been hitherto published concerning what is probably the most aberrant of the very few freshwater Medusæ at present known to us.

The specimens were preserved in strong alcohol and were much blackened by the osmic acid which had been employed as a fixing agent, and which had acted especially upon the margin of the umbrella and the manubrium. In size the individuals varied from 1 to 1·8 centimetre across the bell, while the largest specimen was as much as 2·2 centim. in diameter.

The umbrella is characterized by its flattened shape, the diameter being about four times as large as the greatest thickness. The central portion of the umbrella, measuring about two thirds of the whole diameter, is much thickened and has the shape of a nearly hemispherical lens (Pl. XIV. fig. 4), while the peripheral portions are very much thinner. The margin of the umbrella is bent over and incurved towards the mouth. The exumbrella is smooth and covered with an epithe-

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* H. von Wissmann, 'Through Equatorial Africa' (English translation), p. 253.

lium of flattened polygonal cells. The velum is well developed in some specimens, but not so conspicuous in others. The circular muscles of the velum (fig. 5, *m.v.*) are arranged on the inner side in separate concentric bands, varying in number according to the breadth of the velum. The muscle-bands near the free margin are always more highly developed than those situated near the attachment of the velum.

The gastrovascular system differs from that of all other Medusæ hitherto described in the relative size of its parts. The mouth and stomach are both circular, widely open to the exterior, and of so great a diameter—two thirds that of the umbrella—that the lips of the mouth probably never completely close the stomach in the adult animal. In all the specimens examined the central portion of the shallow stomach-cavity is almost completely filled with the large central lens-shaped boss of the umbrella (fig. 4), so that the stomach is reduced to a circular trench all round the central boss inside the manubrium, and can hardly be said to possess any central cavity at all. It might be suggested that this extraordinary condition is merely due to post-mortem changes; but the fact that the relative dimensions of the parts do not vary appreciably in any of the specimens examined, seems to me to be sufficient reason for regarding the condition described as the normal one, at any rate when the animal is not feeding. A possible explanation of this curious dilatation of the mouth and stomach was suggested to me by Mr. G. C. Bourne. It is obvious that any increase in the diameter of the mouth and stomach would involve a corresponding increase in the circumference of the manubrium, which, as will appear in the sequel, is the bearer of the reproductive organs. The large size of the mouth would appear, then, to be correlated with an enlargement of the area upon which the reproductive organs, sexual or asexual, are developed.

The slightly thickened margin of the mouth is quite simple, without processes of any kind. The radial canals are four in number in the majority of individuals; but instances of the occurrence of five or six seem to be by no means rare, specimens with six being rather more numerous than those with five. The radial canals radiate from the stomach in a more or less horizontal plane, but assume a more vertical direction just before they enter the ring-canal, in consequence of the inflexion of the margin of the umbrella. The ring-canal varies in size in different individuals; it is lined by an epithelium of small squarish cells, similar to those lining the radial canals. On the outer side of the canal, however, these cells are in very great numbers, forming a lobulated mass projecting into and partly blocking up the lumen of the canal (fig. 5). Hollow cavities often occur in this lobulated mass of endoderm-cells.

As in *Limnocodium*, the tentacles are very numerous and may amount to over two hundred in number. In some of the smaller specimens the four primary perradial tentacles are conspicuous on account of their greater length and thickness, but in most of the larger examples they are almost equalled in point of size by the interradial and even the adradial tentacles, so that they are no longer readily recognizable. Alternating with these primary, secondary, and tertiary series tentacles of the fourth and even of the fifth and sixth orders arise with great regularity, and it is only when the seventh order of tentacles are intercalated that the typical regularity of arrangement cannot be further traced. In preserved specimens the relative length of the tentacles varies to a great extent, indicating a considerable capability of contraction and extension. The tentacles are hollow, the lumen of the larger tentacles at any rate being clearly continuous with the lumen of the ring-canal. The lumen of the tentacles is lined with large, thin-walled, columnar endoderm-cells, which are continuous with the endodermic lining of the ring-canal (fig. 5). The transition from the tentacular endoderm-cells to those of the ring-canal is very abrupt. The thread-cells are of small size and generally arranged in little wart-like groups or batteries (fig. 5), which are more or less disposed in whorls and which are especially closely set at the tips of the tentacles.

The proximal ends of the tentacles are all adnate to the margin of the umbrella for some considerable distance (figs. 4 and 5, *te.*), the older tentacles being adherent along a greater length than the younger ones. At the points of fusion the tentacles become partly imbedded in the substance of the margin of the umbrella, while the tentacular ectoderm becomes continuous with that of the exumbrella, so that in a section across the line of fusion an ectoderm lamella is seen between the mesoglœa of the tentacle and that of the umbrella (fig. 5, *ect.*).

On the side of the ring-canal opposite to that at which the tentacles arise and just external to the origin of the velum is situated a circle of sense-organs. These vary considerably in number and are arranged at irregular intervals, so that neither their number nor grouping can be brought into relation with that of the tentacles. The structure of these marginal bodies is peculiar.

They are refringent egg-shaped bodies attached to one side of a round or ovate capsule, the walls of which are lined with a flattened epithelium (fig. 7; *s* in figs. 4 and 5). These egg-shaped bodies are composed of numerous cells and apparently attached by a thin stalk or thread to that side of the capsule which is nearest the ring-canal. The basal cells of the marginal bodies have a granular and opaque appearance, being coloured dark brown by the action of the osmic acid. The apical cells, however, are quite clear and refringent (fig. 8). These extraordinary bodies at once recall the corresponding structures in *Limnocodium* described by Professor Ray Lankester*, to which they bear a remarkably close resemblance. At the same time they differ in structure from all other sense-organs hitherto described in Medusæ, the chief difference between the marginal bodies of *Limnocnida* (as I shall call the Tanganyika Medusa) and those of *Limnocodium* consisting in the absence of any tubular extension of the capsules into the adumbral ectoderm layer of the velum as is the case in *Limnocodium*. Another less important point of difference lies in the marked contrast between the granular basal cells and the refringent apical cells in the marginal bodies of *Limnocnida*. However, in spite of these differences there is a very great similarity of structure in the organs of both, and probably the marginal bodies of *Limnocnida* will be shown to be endodermal in origin, just as the "refringent bulbs" of *Limnocodium* have been proved to be.

Among the individuals of *Limnocnida* examined some were found to have the outer wall of the manubrium quite smooth, while others have the proximal half of the manubrium covered with small swellings visible to the naked eye. When subjected to microscopic examination the individuals with the smooth manubriums turned out to be males and females with the external wall of the manubrium covered with spermatozoa or ova in all stages of development.

The other set of individuals with the small swellings proved to be examples showing stages of bud-formation. Buds may originate anywhere on the basal half of the manubrium, so that in some specimens several rows of buds occur, completely encircling that organ.

As far as the method of bud-formation has been observed at present, it appears that the young buds first arise as outgrowths on the external wall of the manubrium. Besides these, a certain number of older buds with rudimentary tentacles occur, projecting into the stomach and presenting the appearance of having actually grown through the

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* "On *Limnocodium Sowerbii*, E. Ray Lankester," Quart. Journ. Micr. Sci. vol. xx., 1880.

wall of the manubrium. I hope, however, to be able to supply further details of this interesting process of bud-formation in a subsequent paper.

As the Tanganyika Medusa is still without a generic name, I propose that of *Limnocnida* for it, with the following characters:—

LIMNOCNIDA, gen. nov.

Umbrella flat, almost disk-like, about four times as broad as high, with a lens-shaped thickening in the middle. Tentacles very numerous, hollow, with bases partly imbedded in and adnate to the umbrella margin. Marginal sense-organs situate along line of attachment of velum, composed of a multicellular mass of refringent cells enclosed in a roundish capsule. Mouth round, two thirds the diameter of animal. Manubrium very short. Stomach shallow, of same diameter as mouth. Radial canals four. Reproduction by budding. Sexual organs situated on the manubrium.

Limnocnida tanganjicæ (Böhm).

Size: diameter of umbrella $\frac{7}{8}$ inch.
Loc. Lake Tanganyika.

As my knowledge of the significance of several points observed in the general anatomy of this freshwater Medusa is as yet very imperfect, I must reserve a more detailed account of these, as well as all discussion of the probable affinities and systematic position of *Limnocnida*, for another paper. If a place has to be found for *Limnocnida* in Hæckel's System of Medusæ we are beset with almost the same difficulties as those which presented themselves in the case of *Limnocodium*. The same battle will have to be fought over again, only the field is changed. Those who considered *Limnocodium* to be one of the Leptomedusæ will refer *Limnocnida* to the Anthomedusæ, while those who regarded *Limnocodium* as one of the Trachomedusæ will have to place *Limnocnida* among the Narcomedusæ.

EXPLANATION OF THE PLATES.

PLATE XIII.

Fig. 1. Side view of *Limnocnida tanganjicæ*, × 4.
Fig. 2. Ventral view of ditto, × 3.
Fig. 3. Ventral view of a portion of the periphery of the disk, × 9.

PLATE XIV.

Fig. 4. Diagram of a transverse section passing along a radial canal on the right hand side but not on the left.
Fig. 5. A radial section cut a little to one side of the opening of a radial canal into the ring-canal, × 60.
Fig. 6. A portion of a tentacle, showing the arrangement of thread-cells.
Fig. 7. A tangential section through two adjacent marginal sense-organs.
Fig. 8. A marginal body seen in longitudinal optical section.

c.c.	Circular canal.	*ms.*	Mesoglœa.
ect.	Ectoderm.	*m.v.*	Muscles of velum.
e.l.	Endoderm lamella.	R.	Radial tentacle.
end.	Endoderm.	*r.c.*	Radial canal.
gem.	Medusa buds.	*s.*	Marginal sense-organ.
IR.	Interradial tentacle.	*te.*	Tentacle.
mn.	Manubrium.	*v.*	Velum.

XLVI.—*Notes on a Specimen of Sowerby's Whale* (Mesoplodon bidens*), *stranded on the Norfolk Coast.* By T. SOUTHWELL, F.Z.S., and SIDNEY F. HARMER, M.A., F.Z.S.

[Plate XV.]

ON the 19th December, 1892, we received intimation that a "large fish" accompanied by a young one had come ashore on the previous day at Overstrand, near Cromer, and on the following day we visited Overstrand together with the expectation of seeing one of the commoner species of Cetacea, but were agreeably surprised to find that the animal which had been stranded was a fine adult female specimen, 16 feet 2 inches in length, of Sowerby's Whale. It had been discovered on the morning of the 18th December left in shallow water by the receding tide, still alive but feeble, and, after being anchored to the shore for security, had been placed on a trolly and carried to the top of the cliff; it died, however, before it was taken from the water. Previously to our arrival on the scene it had been eviscerated, and was lying in a shed on the top of the cliff, a fœtus, 5 feet 2 inches long, having been extracted from it.

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* Professor Sir W. Turner, in a recent paper on its occurrence in the Firth of Forth, has adopted the generic name *Micropteron* for this animal, as proposed by A. Wagner in 1846, and used by Eschricht and G. Cuvier; but for the reasons assigned by Professor Sir W. Flower, in a footnote to his paper on the "Recent Ziphioid Whales" (Tr. Z. S. viii. p. 208), we prefer to retain the more familiar term *Mesoplodon*, as applied by M. P. Gervais in 1850.

We are informed that both mother and young are being stuffed and the skeleton of the former mounted for the Hon. Walter Rothschild, for whom they were purchased, being intended for his museum.

Eighteen examples of this species have been previously recorded, all from the North Atlantic, but in only one previous instance has it been met with in England, namely at Spurn Point in 1885 *, and with five exceptions all have been males; nor has any perfect specimen in a fresh condition ever been fully described, unless, indeed, the young female taken at Atlantic City in March 1889 should prove an exception; but of this we have at present received no particulars. We were therefore glad of an opportunity of examining so good a specimen under comparatively favourable, although not altogether satisfactory, circumstances, for the animal was unfortunately lying in such a position that it was impossible to obtain a photograph of it, and one side only could be seen. We regretted this the more as, although several figures of Sowerby's Whale have already been published, most of them are not completely satisfactory in all respects, and we should have been glad to have secured a good photograph; but the accompanying figure (Pl. XV.) has been carefully reconstructed from sketches and measurements made on the spot.

Of the original published figures the best with which we are acquainted is that of Reinhardt †, which is unfortunately contained in a journal not easy of access to English readers; other figures more or less satisfactory have been given by Sowerby ‡, Dumortier §, Andrews ||, &c., and a figure of a head has been recently published by Sir William Turner ¶ from a photograph which differs in several noteworthy particulars from the specimen examined by us, especially in the proportions of the rostrum and lower jaw. The coloration of the body also differs considerably in the various descriptions; but to these we shall have to refer later on, and will proceed to give the results of a careful examination of the specimen under consideration.

The two remarkable mandibular teeth so characteristic of the adult male of this species were not visible in our specimen,

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* Southwell and Eagle Clarke, Ann. & Mag. Nat. Hist., Jan. 1886, p. 53.

† Oversigt over d. Kong. Danske Vid. Selskabs, Copenhagen, 1880.

‡ J. Sowerby, 'The British Miscellany,' 1804–1806, vol. i. pl. i.

§ B. C. Dumortier, "Mém. sur le *Delphinorhynque microptère*," Nouv. Mém. de l'Acad. Roy. de Bruxelles, xii., 1839.

|| W. Andrews, "On *Ziphius Sowerbyi*," Trans. Roy. Irish Acad. xxiv. 1871, pl. xxv.

¶ Proc. Roy. Phys. Soc. Edinburgh, x., 1888-89.

which was a female. The jaws were apparently completely edentulous, and although it was possible to feel through the gums a slight prominence on either side in the position of the teeth of the male, we could not by this means definitely satisfy ourselves with respect to this point, nor were we able to ascertain the presence of any other rudimentary teeth in either jaw. The evidence which exists on this subject is favourable to the view that the female of this species is not provided with any teeth which are large enough to pierce the gums. Both the rostrum and the lower jaw were distinctly longer and more slender than in Sir William Turner's specimen, in our comparisons with which the difference in sex and age must be borne in mind. The rostrum and lower jaw together were nearly cylindrical when the mouth was closely shut and both were evenly rounded at the tip, the lower jaw projecting about half an inch beyond the rostrum. The contour of the mouth also differed considerably from that of the specimen figured by Sir W. Turner—the mandible passed backwards in a nearly straight line for a considerable distance, the lower edge of the mouth then curving upwards and again downwards. The gape was small, the angle of the mouth being nearly 4 inches in front of the point of junction of the upper and lower lips, which, behind the angle of the mouth, bounded a groove continuing the direction of the mouth. Beneath the lower jaw were the two singular gular sulci characteristic of the members of the subfamily Ziphiinæ; these were expansible straight grooves in the skin 11¾ inches long, converging at their anterior ends, which were only half an inch apart, and diverging to their posterior ends, which were separated by an interval of 9½ inches.

The eye was contained in a horizontal slit 1¼ inch long, the iris being brown; the pupil, a long oval with its major axis horizontal, appeared to be black. It was situated at a distance of 7½ inches from the termination of the furrow formed by the mouth-slit and 11¼ inches behind the actual angle of the mouth.

The aperture of the ear was very minute and not easy to discover in the adult specimen; a comparison with the fœtus, however, enabled us to convince ourselves that a minute aperture situated about 3 inches behind the eye in the adult specimen, and into which we were able to pass a fine bristle, was really the external auditory meatus. This aperture was distinctly below the level of the eye, as shown in Reinhardt's figure, and not in a line with it as in Sir W. Turner's* figure.

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* *Loc. cit.*

The blow-hole was slightly in advance of the eye and was crescentic in shape, the horns of the crescent pointing forward. The major portion of the blow-hole was situated to the left of the medial line of the head, but we could not detect any other asymmetry in the arrangement of this aperture. In Sir W. Turner's specimen the right limb of the crescent was slightly in front of the left.

The head was very prominent dorsally for a short distance in front of the blow-hole.

The pectoral limb was relatively small and was situated at a low level on the animal, convex on both its borders and somewhat sharply pointed. A cutaneous groove passed forwards from its anterior end, continuing the line of its lower margin *, the length of the lower border, measured along the curve from the anterior end of this groove, being 1 foot 9½ inches, whereas the length of the upper border (also measured along the curve) was 1 foot 5¼ inches.

The dorsal fin was situated considerably behind the middle of the animal (not quite two thirds) and was strongly falcate behind; its base measured 1 foot 1¾ inches and its height was 7½ inches. The commencement of the fin was 10 feet 2 inches from the tip of the rostrum, and the posterior end of its base was 5 feet 11 inches from the middle of the border of the dorsal fin, both measurements following the curve of the back.

The greatest dorso-ventral diameter (3 feet 5 inches) was about midway between the pectoral and dorsal fins. The large size of the middle of the body, which tapered to much smaller dimensions at either end, was one of the most obvious of the external features of this specimen, and in this it agreed closely with the published accounts of other individuals; it must not, however, be forgotten that the Overstrand specimen was in a pregnant condition when captured.

The body became laterally compressed near the tail, and both the dorsal and ventral edge formed a conspicuous ridge or medial keel passing a short distance along either surface of the tail, which was entire on its posterior border, the place of the medial notch, as in *Hyperoodon*, being taken by a slight convexity, which in this specimen had, however, been somewhat abraded by the rope used in its capture. The flukes of the tail measured 3 feet 8 inches from tip to tip.

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* This could not be shown in fig. 1, in which what is apparently the insertion of the limb is really the termination of the cutaneous groove mentioned above.

Coloration.

Previous observers have described this animal as being lighter beneath than above. This was distinctly not the case in the specimen under consideration, which was of a uniform black colour (with the slight exceptions shortly to be mentioned), the skin being very smooth and polished, as has been described in other instances; and the fishermen in charge who had assisted in its capture informed us that at first there was a perceptible bluish tint on the skin in a good light. But the most remarkable feature was the presence of a number of curiously shaped marks sparsely distributed over the body, but most numerous on the side and ventral surface. These spots were most irregular in size and figure, some being annular, others mere blotches, others again having the appearance of splashes or smears varying in size up to that of a man's hand. One peculiar mark in the dorsal region consisted of several horizontal lines crossed by two others in a nearly vertical direction. These curious markings, which seem somewhat to resemble the markings on *Grampus griseus*, have been frequently referred to, and seem to differ considerably in different individuals; but certainly in this instance there was very little resemblance to the "vermicular streaks" described and figured by Sowerby *, and with which he stated the sides of his specimen were "completely covered." We have not attempted to reproduce these markings in the accompanying figure.

The colour was not appreciably lighter on the belly than on the back; the anterior edges of the tail-flukes were grey, that colour shading off gradually into the general black hue of the rest of the tail. The lower jaw was grey in front, but became distinctly white near the posterior end of the slender part of the jaw, the white colour extending some distance backwards along the edge of the mouth; the upper jaw was greyish, its edges being white, the inside of the mouth black, and the small tongue, which was only free at the point, flesh-coloured.

The fœtus (Pl. XV. fig. 2) had been removed from its membranes and the umbilical cord severed close to the body; it resembled the adult in its general characters, but of course was much less robust in appearance; the grooves of the throat were well developed and the fins were identical in position and form with those of the parent, the most noteworthy point of difference being the

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* Sowerby, 'British Miscellany,' pl. i.

relative shortness of the jaws as compared with the adult. The Ziphioid elongation of the beak had not yet been acquired, and no trace of teeth could be detected in either jaw.

The colour of the fœtus was black above and red below, the latter colour being due to the effusion of blood into the skin, which was doubtless white when the fœtus was removed from the uterus. Parts of the head, including a horizontal streak passing through the eye, were bluish grey, and the first two inches of both the upper and lower jaws were black.

Table of Measurements.

	ADULT.		FŒTUS.	
	feet.	in.	feet.	in.
Extreme length in straight line from tip of rostrum to middle of tail	16	2	5	2
Girth of head round eminence in front of blow-hole	2	8½		
Girth in plane of blow-hole	3	4		
Girth in plane 4½ inches behind eye	4	5		
Transverse diameter of blow-hole		4		
From tip of lower jaw to angle of mouth.	1	5½		5¼
" " " " posterior end of the groove running back from the angle of the mouth	1	9¼		7
From tip of upper jaw to angle of mouth.	1	5		5
From eye-slit to angle of mouth		11¼		
Antero-posterior diameter of eye-slit		1¼		
From eye-slit to vertical line passing through external auditory meatus ..		3		
From horizontal line produced back from eye-slit to external auditory meatus		2		
Greatest dorso-ventral diameter of the part of the head in front of the blow-hole............................	1	3¾		
Length by which mandible projects beyond rostrum....................		½		
Height of dorsal fin		7½		3¼
Length of base of dorsal fin............	1	1¾		4½
From tip of upper jaw to front end of base of dorsal fin (measured along curve of back)	10	2	3	3
From posterior end of base of dorsal fin to middle line of tail (measured along curve of back)	5	11	1	8½
From tip to tip of flukes (measured in a straight line)	3	8		
Length of slits for mammæ		2¾		
Length of lower border of pectoral fin (measured along curve from front end of groove extending forwards from base of fin)....	1	9½		9

	ADULT.		FŒTUS.	
	feet.	in.	feet.	in.
Length of upper border of pectoral fin (measured along curve)	1	5¼		8
Length of grooves beneath lower jaw		11¾		
Distance between front ends of the above grooves		½		
Distance between hind ends of the above grooves		9½		
Greatest dorso-ventral diameter (2 feet 8 inches in front of dorsal fin)	3	5		

Of the general history of the Ziphioid whales Sir W. H. Flower has given an admirable summary in his paper "On the Recent Ziphioid Whales," which will be found published in the 'Transactions of the Zoological Society of London,' vol. viii. p. 203 (1871), and "A Further Contribution to the Knowledge of the existing Ziphioid Whales: Genus *Mesoplodon*," which appeared in the same publication, vol. x. p. 415, in 1877: and of the anatomy and, to some extent, of the external appearance Sir William Turner has contributed most valuable papers, which have appeared from time to time in the 'Journal of Anatomy and Physiology;' but unfortunately the specimens which came under the notice of this excellent anatomist have never been in such a condition as to enable him to give the exhaustive description of the exterior appearance of the animal which we should certainly have received had the material been at his disposal.

The same may be said to a greater or less degree of the continental naturalists, and Sowerby's type specimen was described by him at second hand; the two Bandon specimens also were so mutilated as to be of little service to science. It thus happens that the skeleton and soft parts of this species are better known than its external appearance. This deficiency we have endeavoured, so far as the Overstrand example is concerned, to supply; but, as so many discrepancies are noticeable between our observations and those which have previously appeared, we venture to append some observations on the published descriptions and original figures of this singular animal. How far these discrepancies may be due to differences of age and sex we have not sufficient evidence to venture an opinion.

SOWERBY, JAMES. 'The British Miscellany,' 1804–1806, vol. i. pl. i. *Physeter bidens* ♂, Elginshire.—The figure in outline closely resembles the Overstrand specimen, the general shape of the body being almost identical, but the head is relatively shorter and the lower jaw more massive, with of course two teeth, indicative of the male sex; the tail is shown with a mesial notch, and the conspicuous keels, both on the upper and lower surfaces of the termination of the body, are absent; the dorsal fin is much less falcate and the pectoral limbs longer, narrower, and less pointed than in the Overstrand specimen. The coloration, "black above, nearly white below," and the sides "completely covered with white vermicular streaks in every direction," differs materially from the specimen we had the opportunity of examining.

Reinhardt, J. "*Mesoplodon bidens*, en Tilvæxt til den danske Havfauna," Oversigt over d. K. D. Vid. Selskabs, 1880 (Kjöbenhavn), p. 63, tab. ii. (adult female, side view, and dorsal view of head and part of the body).—This appears to be a very good figure; the external auditory meatus is shown in much the same position as in the Overstrand specimen, but the contour of the head differs in having a deep depression at the base of the skull and in the body being less fusiform. The animal had been dead for over a month when Reinhardt examined it *, and, except in a few places, nearly all the cuticle was removed, which may account for the auditory meatus being so conspicuous, probably also for the occipital depression already mentioned. The only reference to colour is the statement that the remains of the epidermis and the interior of the mouth were blackish. On the shrinking of the integuments two small functionless teeth about the size of a pin's head were seen on each side of the *upper* jaw, so loosely lodged that they were freely movable; a third could be felt on cutting into the skin, and, more posteriorly, apparently a fourth, but no trace of teeth could be found in the mandible, though the author suggests that they also were probably present in this specimen.

Andrews, W. "On *Ziphius Sowerbyi* (*Mesoplodon Sowerbiensis*, Van Beneden)," Trans. Roy. Irish Acad. xxiv., 1871 [read 8th April, 1867], p. 429, pl. xxv. figs. 1, 2, 3: 1, side view of frontal portion of head; 2, upper portion of head; 3, under portion, showing the throat-furrows; all from photographs. ♂.—Teeth very conspicuous and throat-furrows figured as uniting in front; irides said to have been blue.

Dumortier, B. C. "Mémoire sur le *Delphinorhynque microptère* échoué à Ostende," Nouv. Mém. de l'Acad. Roy. de Bruxelles," tome xii., 1839, pl. i., *Mesoplodon bidens* ♀, stranded at Ostend, Aug. 21, 1835.—The figure is on the whole good, but the following criticisms may be made. The shape is much the same as that of the Overstrand specimen, but the attachment of the caudal fin is not accurately drawn, and both the dorsal

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* We are indebted to Sir William Turner's paper in the 'Journal of Anatomy and Physiology,' 1882, p. 459, for a translation of the substance of Reinhardt's remarks.

> and pectoral fins appear to be too large. The mouth is widely open, but no groove running backwards from its angle is shown. The length is stated to have been 3 metres 45 centim. (=11 feet 4 inches), and the animal was kept alive out of the water for two days; it made a noise like a cow. The colour was "brunâtre plombée," except the ventral surface, which was "blanchâtre et cendré." Plate ii. shows skeleton, plate iii. hyoid and other details.

The first known example of this species was met with in the year 1800; after twenty-five years two others were procured in France; an interval of ten years elapsed (1835) before the next specimen was obtained on the Belgian coast at Ostend; nothing more was heard of the species till 1864, in which year, also in each of the years 1866, 1867, 1869, 1870, and 1872, a single individual was procured; the next example was obtained in 1880; 1881 produced two, 1885 three, 1888 one, 1889 one, and 1892 one—nineteen examples in all. Of seventeen instances in which the sex was known or believed to be known eleven were males and six females; we mention this preponderance of males as being the reverse of what occurs with regard to the nearly allied *Hyperoodon*, the adult male of which has never been met with on our coast, although large numbers of both sexes congregate in summer in the seas between Iceland and Jan Mayen and the females are regular spring and autumn visitors in the North Sea on their way to and from their summer habitat; but the line of migration of the males appears to be different to that followed by the females.

Again, with regard to the seasons at which it has been met with, Sowerby's Whale displays none of the regularity which marks the movements of the *Hyperoodon*; an analysis of the dates shows that it has been met with in February once, March twice, April once, May twice, June once, "summer" once, August twice, September twice, October twice, and December once, the bulk having been stranded on the shores of the North Sea and of the English Channel, and on the south-west coast of Ireland; *i. e.* from the Shetland Isles to the north of France. It may be that the February and December examples were belated wanderers which had lost their way; but the occurrence of so many examples between the months of March and October would seem to indicate that the waters of the North Sea represent the extreme northern boundary of the wanderings of this species; their southern habitat is quite unknown, except that two have been met with on the western side of the North Atlantic, at Nantucket Island

and Atlantic City, the latter in the month of March. Judging from the hopeless way in which it becomes entangled in the sandbanks and shoals of a shallow coast, it would seem to be unaccustomed to such impediments, and is probably a deep-water species. It is also worthy of note that the Overstrand *Mesoplodon* was within a short time of giving birth to a young one, whereas the young of the *Hyperoodon* are produced in the months of May and June.

Notwithstanding the very great advance which has been made in our knowledge of the Cetacea of late years, we are still very ignorant with regard to the habits and distribution of many species, and it is most desirable to place on record every circumstance which may tend, even indirectly, to throw light on a subject of so much interest.

EXPLANATION OF PLATE XV.

Fig. 1. *Mesoplodon bidens*, ♀, seen from the left side. Scale 1 : 40. The arrow *a* indicates the position of the blow-hole; *b*, gular sulcus; *c*, eye; *d*, external auditory meatus.

Fig. 2. Fœtus which belonged to the above specimen, seen from the left and slightly from the ventral side. From a photograph taken by Mr. W. D. Harmer. Scale 1 : 12. *b* and *c* as above; *e*, right pectoral limb.

XLVII.—*Note on the Genera* Geothauma *and* Gyrostropha.

By Edgar A. Smith.

The genus *Geothauma* has recently been proposed by M. Crosse * for the reception of that most wonderful little shell described by Lieut.-Col. Godwin-Austen under the name of *Opisthostoma grandispinosum*. M. Crosse considers the trochoid form, the spinous ornamentation, and the manner in which the last whorl is produced upward to the top of the spire of sufficient importance to distinguish it generically from the typical species of *Opisthostoma* from India. Many of the characters given in the diagnosis of the genus are specific rather than generic. This may have arisen from the fact that M. Crosse appears to have had but a single species in view at the time. At all events, it is unsatisfactory that he has not expressed his views regarding the other known species of *Opisthostoma* from Borneo, namely *O. de Crespignyi*, H. Adams, *O. Wallacei*, Ancey, and *O. pulchellum* and

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* Journ. de Conch. 1892, p. 282.

O. Hosei of Godwin-Austen. In addition to these I have just described five other species from the same island.

A careful study of all these species seems to prove that the genus *Geothauma* is not required, at all events at present.

The form is sometimes as "pupiform" as in the Indian species, e. g. *O. baritense*, Smith; the last whorl in *O. basanense*, Smith, ascends and presses against the penultimate, and the sculpture varies from the finest lamellæ, as in *O. baritense* and *O. Wallacei*, to much stronger lamellations, as in *O. jucundum*, Smith. In *O. pulchellum* the lamellæ are produced at the middle of the whorls, occasionally forming hollow spine-like projections. In *O. Everetti*, Smith, these productions are still more developed, and in *O. mirabile*, Smith, they are as remarkable as in *O. grandispinosum*.

The height to which the last whorl may be produced upward is also a matter of degree. For instance, in *O. Hosei* and *Everetti* it rises almost as high as the top of the spire, whereas in *O. baritense* it does not ascend beyond the penultimate whorl. Most conchologists would at a glance confess that these ten species from Borneo are evidently modifications of one type; and, even supposing that they differed materially from the Indian forms, which is not the case, a new generic name was not required for them.

In 1865 Mr. H. Adams* described the genus *Plectostoma* for the *O. de Crespignyi*, and this, as it does not appear to have been preoccupied in any other branch of zoology, is still available. However, until some distinguishing differences are discovered in the anatomy of the animals, it seems to me altogether impossible with reason to separate the Indian and Bornean species on conchological grounds †.

In my opinion the genus or subgenus *Gyrostropha* is equally useless. It was suggested by M. Ancey ‡ to include *O. paulucciæ*, Crosse and Nevill, and *O. perakensis*, Godwin-Austen and Nevill, from Perak. He considered that they should be separated from the typical Indian forms, because the summit of the spire was supposed to be roundly obtuse or subglobose and the aperture situated almost in a vertical plane parallel to the axis. Can anything be more trivial than this? We might as well separate generically shells having but five instead of five and a half volutions!

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* Ann. & Mag. Nat. Hist. 1865, vol. xv. p. 177.

† Mr. W. T. Blanford has already expressed a similar opinion (Ann. & Mag. Nat. Hist. 1867, vol. xix. pp. 305, 306).

‡ Bull. Soc. Mal. France, 1887, p. 275.

XLVIII.—*On the Variety* cinereo-niger, *Wolf, of* Limax maximus, *L.* By Walter E. Collinge, Demonstrator of Biology in Mason College, Birmingham.

In the 'Annals' for March Mr. Roebuck objects to my classing the *Limax cinereo-niger*, Wolf, as a colour-variation of the well-known *L. maximus*, L., and puts forward an argument for the retention of this slug as a distinct species or subspecies.

He contends that it differs from *L. maximus* in its "dentition," the anatomy of the reproductive organs, and in its external form and coloration. When I stated * that there were no differences of importance in the general anatomy, I did not think it necessary to enter into details as to the slight variations and modifications to which all the Mollusca are subject, according to age, season of the year, habitat, &c., for both Simroth † and Scharff ‡ had previously described the anatomy, and I stated that my investigations agreed with the accounts given by them.

It seems, however, since Mr. Roebuck has become convinced that he was wrong in stating that there were important differences in the reproductive organs, solely upon the observations of Sordelli §, that he now intends to uphold its specific distinction upon some drawings &c. made by Mr. Charles Ashford which exhibit some slight variations from one another, and upon some observations on the lingual ribbon.

The lingual ribbon, which Mr. Roebuck regards as of such importance, is, for generic or specific distinction, of little or no value; indeed, such is its unreliability that not a few malacologists totally ignore it.

Simroth, who has had more experience with the anatomy of the slugs than any other living investigator, years ago showed the great variation it was subject to, and that it "was perhaps the most unsuitable portion of the slug's body" that could have been chosen for purposes of classification. Indeed a large number of species constituted upon differences in the lingual ribbon he conclusively proved by a series of careful anatomical investigations to be but varieties of *L. maximus*, whose lingual ribbon is subject to endless variations. The

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* Ann. & Mag. Nat. Hist. 1892, vol. x. p. 425.

† Zeitschr. f. wiss. Zool. 1885, vol. xlii.

‡ Trans. Royal Dublin Soc. 1891, ser. 2, vol. iv. p. 518.

§ I think Mr. Roebuck's statement "important differences" is hardly borne out by Sordelli's original account.

only malacologists I can call to mind who use it to-day are Binney and Pollonera, and both give it quite a secondary place. I therefore am of opinion that, from a consideration of its development and variation, it is absolutely useless for specific or generic distinction.

Respecting the reproductive organs, I regret Mr. Roebuck has not a knowledge from personal examination. Accurate as Mr. Ashford's drawings may be—and I see no cause to doubt the particulars given—personal observation of the reproductive organs of a few slugs would, I think, at least have shown him that to separate species of slugs upon any single system is unsafe, if not unscientific. My contention is that the general anatomy—the reproductive, nervous, digestive, and muscular systems—of *cinereo-niger* is the same as that of *L. maximus.* All who have had any experience in the anatomical examination of the Mollusca know the endless minor variations that occur in the form, size, and colour of the reproductive organs, according to age, season, habitat, &c. The writings of Simroth, Lessona, Pollonera, Scharff, Jourdain, Binney, and others will bear out my statement. It is therefore needless for me to dwell upon these slight variations Mr. Roebuck has seen in Mr. Ashford's drawings.

I have frequently of late dwelt upon the external variations of the slugs in form and colour, and I was careful to point out that I agreed with Jourdain that species could not be founded or separated from each other upon these minor differences. Mr. Roebuck says he has examined "by far the greater proportion of British specimens known"; and yet it seems to me that he is still ignorant of very many of the variations to which *L. maximus* is subject. Seeing that the actual published records of *cinereo-niger* are but few, I can only regard his statements *re* variation as founded upon an insufficient knowledge of the subject. Personally I have only seen about one hundred examples of *cinereo-niger* and some seven or eight hundred of *L. maximus*, most of which I have subjected to a careful examination, and many anatomically. Amongst these I have met with both *L. maximus* and its variety *cinereo-niger* with the marblings on the mantle and with a white foot-sole also.

In conclusion, I fail to see any points which are of sufficient importance to establish the specific identity of *cinereo-niger*, and until such are shown to exist I shall, with the above-mentioned malacologists, continue to regard it as a variety of *L. maximus.*

XLIX.—*On some Japanese* Scaphidiidæ.

By G. Lewis, F.L.S.

The following notices record the larger species only of the Scaphidiidæ I found in Japan. To complete the list numerous species of *Scaphisoma* have yet to be examined, and at present only three species have been described by Reitter; the names of these are given in the list below. There are doubtless more species to be found in Japan by resident collectors; but the species are easily found, for they can scarcely be said to habitually secrete themselves, and I think it unlikely the number will be greatly increased. Numerically in all countries the Scaphidiidæ are always far below the other families which infest fungi, such as the Staphylinidæ, Erotylidæ, and Endomychidæ. Some of the maculate species of *Scaphidium* resemble in colour and general markings certain Carabidæ (*Lioptera*) and Erotylidæ (*Episcapha*), which also congregate in arboreal fungi; these species in Japan are limited to five. I have placed all the species possessing a hairy sternum in the male in the genus *Scaphidium*, but I have excluded all the others, as I find their structure, especially that of their sternal plates, necessitates separation.

List of described Species.

Ascaphium sulcipenne.
—— tibiale.
—— apicale.
Scaphium optabile.
Episcaphium semirufum.
—— ruficolle, var.?
Scaphidium emarginatum.
—— longipes.
—— japonicum, *Reitter.*
Scaphidium femorale.
—— Reitteri, *Lewis.*
—— rufopygum.
—— incisum.
Cyparium sibiricum, *Solsky.*
Toxidium japonicum, *Reitter.*
Scaphisoma hæmorrhoidale, *Reit.*
—— rubrum, *Reitter.*
—— castaneipenne, *Reitter.*

Ascaphium, gen. nov.

Body narrowly oval or elliptical, rather convex; the head, neck, and anterior part of the thorax somewhat narrow; antennæ and palpi slender, each joint of the first cylindrical and setose, the last five joints of nearly equal length. The thorax has the usual transverse line of punctures; the scutellum is semicircular posteriorly; the elytra punctate-striate. The mesosternum is anteriorly rounded off in a vertical direction on each side, leaving a prominent median keel on the same plane as the metasternum; the metasternum is margined anteriorly with an arched stria, and the edge of this plate is feebly bowed in outline; from the base to beyond the middle is a median cuneiform depression (e. g. *A. sulcipenne*), or the limit of the depression is indicated by two striæ (e. g. *A. tibiale*); the legs are slender, and in two species the tarsi alone give a sexual character.

Ascaphium sulcipenne, sp. n.

Angustato-ovatum, nigrum, nitidum; ore, antennis pedibusque rufis; elytris striis profundis et punctato-striatis.

L. 6½ mill.

Narrowly ovate, black, shining; epistoma, mouth-organs, and antennæ reddish; the head irregularly punctulate between the eyes, neck smooth; the thorax finely and sparsely punctulate on the disk, nearly smooth behind the transverse punctures; the elytra—striæ seven, very deep, with a single row of punctures along each, the sutural stria continues in the form of punctures along the base, two striæ next to the sutural are a little abbreviated apically, the sutural margin is a little elevated; the legs are without any conspicuous differences in the male, but the tarsi are slightly wider and serve to distinguish the sexes.

Hab. Nikko and Miyanoshita. Scarce, six examples only.

Ascaphium tibiale, sp. n.

Angustato-ovatum, nigrum, nitidum; elytris punctato-striatis; tarsis rufis, ♂ tibiis anticis longioribus.

L. 5–5¾ mill.

Elliptical, black, shining, mouth-organs and tarsi reddish; the head distinctly but not densely punctured between the eyes, neck nearly smooth; the thorax punctured like the head, but less densely; the elytra punctate-striate, but much less deeply than in *A. sulcipenne*, the outer stria punctiform and evanescent; the sutural continues along the base, the two striæ next the sutural are of equal length and shortened before the base; the pygidium rufous at apex; the legs in the male are elongate and swollen rather nearer the tarsi than the middle. The five apical joints of the antennæ are black, the others pitchy red.

Distinguished from *A. sulcipenne* by the smaller size, black legs, elytral striæ much less deep, and by the masculine character in the tibiæ.

Hab. Miyanoshita, Subashiri, Nikko, and Oyayama. Not uncommon.

Ascaphium apicale, sp. n.

Angustato-ovatum, nigrum, nitidum; antennis articulis apicalibus rufis; tibiis nigris vel rufo-piceis.
L. $3\frac{1}{2}$ mill.

Elliptical, black, sometimes faintly metallic; mouth-organs, six basal and the apical joints of the antennæ red; the head clearly, not densely punctulate; the thorax similarly punctured; the elytral sculpture resembles that of *A. tibiale*; the legs are black or pitchy red.

This species is smaller than *A. tibiale*; the apical joint of the antenna is pale or red and the anterior tibiæ are alike in both sexes.

Hab. Found in the same localities as the last species. Rare.

Scaphium optabile, sp. n.

Oblongo-ovatum, nigrum, nitidum; supra punctulatum; antennis pedibusque concoloribus; metasterno inciso.
L. 4 mill.

Oblong-oval, black, shining; head robust, somewhat closely punctulate; the thorax more distinctly punctured and the punctures less close, the stria behind the neck very fine, leaving a narrow smooth margin; the elytra with the sutural stria punctate, entire, and continuing along the base, surface punctured more finely than the thorax, but without linear arrangement; the propygidium has an elevated margin at the sides, and the base of the pygidium is laterally somewhat similar; both segments are finely punctulate; the claws are pale. The mesosternum is formed like that of a species of *Scaphidium*, transverse, margined anteriorly, and acutely produced in front; and the metasternum is truncate anteriorly, with a median longitudinal canaliculation, and behind, the edge is conspicuously incised in the middle and rounded off on either side of the incision.

This curious species, being unique in my collection, is assigned to *Scaphium* because of the incision in the metasternum, but provisionally only, as in *Scaphium* the mesosternum is robust and triangular and in this insect it is formed more like that of *Scaphidium*.

Hab. Ichiuchi, in Higo, May 1st, 1881.

EPISCAPHIUM, gen. nov.

Body oval, convex; the head, neck, and anterior part of thorax narrowed; the antennæ not very slender, the last five joints are thickened but not compressed, ninth and tenth equal in size, but not transverse like those of *Scaphidium*; eyes large and a little prominent; scutellum semicircular posteriorly; the thorax with transverse line of punctures; the mesosternum is much less wide than in *Scaphidium* and the anterior process is much more produced, has parallel sides, and is carried forward in the form of a keel; the metasternum is margined with an arched stria. The elytral striæ are all punctiform except the sutural.

Episcaphium semirufum, sp. n.

Oblongo-ovatum, nigrum, nitidum; elytris, pygidio tarsisque rufis. L. $4\frac{1}{2}$–5 mill.

Oblong-oval, convex, shining, black, with elytra, abdominal segments, tarsi, and basal joints of antennæ red; the head clearly, evenly, and somewhat closely punctured; the thorax with the punctures faint and scattered; the elytra with the sutural stria punctate, complete, and continuing along the base, surface with punctures arranged in lines more or less broken, the rows nearest the humeral angles being the best defined; the legs black, without sexual differences.

Hab. Nikko, Kiga, and Miyanoshita. Not very common.

Note.—I took a series (seventeen specimens in all) in Kiushiu, at Yuyama, Ichiuchi, Konose, and other places with the thorax, except a narrow rim behind the neck, red, to which I wish to apply the name of *A. ruficolle*. It may be a variety, but, if so, it is a constant one in South Japan.

The five species following have maculate elytra:—

Scaphidium emarginatum, sp. n.

Ovatum, convexum, nigrum, nitidum; elytris duabus maculis dentato-sinuatis, rubris; ♂ tibiis anticis intus minute emarginatis. L. $6\frac{1}{2}$–7 mill.

Oval, convex, black, shining, each elytron with two red denticulate fasciæ; the head feebly and sparsely punctured between the eyes; the thorax more distinctly punctate before the basal punctiform line, smoother behind it; the elytra with a somewhat stronger punctuation, especially in the dorsal region, sutural stria rather fine and punctulate, deeper with large punctures along the base; anterior fascia touches the base below the humeral angle, leaving on the humeral angle a black nearly circular space; the red colour does not touch the base on the sutural side; posteriorly the fascia has three distinct tooth-like projections; the posterior fascia is smaller, with only two denticulations, which point towards the head; the antennæ with the last five joints broad and densely black, ninth and tenth nearly equal in size, basal joints pitchy red. Male anterior tibiæ swollen apically on the inner edge, and in the middle of the bulge there is a small but very distinct emargination.

This species differs from *S. japonicum*, Reit., in having broader apical joints to the antennæ, in the outline of the denticulate elytral fasciæ, and in the tibiæ of the male being emarginate.

Hab. Occurs on the mountains in Kiushiu, and has been found at Chiuzenji and on Ontaki-san.

Scaphidium longipes, sp. n.

S. japonico simillimum, sed pedibus multo longioribus; femoribus anticis minute denticulatis; elytris duabus maculis sinuatis rubris.

L. 7 mill.

Oval, black, shining, each elytron with two red fasciæ; the fasciæ are much less wide than in *S. emarginatum* and agree more closely with those of *S. japonicum*; the anterior band has two ill-defined denticulations on the hinder edge, the posterior band usually has two denticulations similar to that of *S. emarginatum*, but not so clearly marked; the legs are much longer and the anterior thighs have a small tooth on the underside nearer the tibiæ than the middle of the limb. The mesosternum also is wider. I see no other characters to separate it from *S. japonicum*, except that it is a little broader in its general build.

Hab. Higo, and on the main island at Kiga and Miyanoshita.

Scaphidium japonicum, Reitter.

Hab. Main Island and Kiushiu.

The commonest species in Japan.

Scaphidium femorale, sp. n.

Ovatum, convexum, nigrum; elytris duabus maculis flavo-rubris; ♂ femoribus robuste dentatis.

L. 4½–5½ mill.

Oval, convex, black, shining, each elytron with two (often somewhat wide) yellowish-red fasciæ; the head, punctuation between the eyes sparse and irregular; the thorax more evenly but not thickly punctured, transverse punctures largest before the scutellum; the elytra with similar punctuation, basal fasciæ rather broad, somewhat irregular in outline, but usually divided into two lobes, in some examples (apparently varieties) the spots are small and confined to the outer edge of the wing-case; the antennæ are black, basal joints a little pitchy.

♂. The anterior tibiæ are swollen on the inner edge and the hindermost thighs have a conspicuous blunt tooth on the inner side not far from the middle of the limb, but nearest to the tibia.

Hab. Main island and Kiushiu.

Scaphidium Reitteri, Lew.

Scaphidium Reitteri, Lew. Ann. & Mag. Nat. Hist. 1879, iv. p. 460.

This is the only species recorded from Japan that has part of the thorax red; in this respect it resembles an American form. Beyond the hairy sternum it has no conspicuous masculine character.

Hab. Vries Island, Kashiwagi, Chiuzenji, and several places in Higo. I also met with it on Maiyasan, near Kobé, in almost the exact spot where I found it ten years previously.

The following species have the elytra wholly black:—

Scaphidium rufopygum, sp. n.

Oblongo-ovatum, convexum, pygidio rufo; pedibus nigris vel rufis.
L. $4\frac{1}{4}$–$4\frac{1}{2}$ mill.

Oblong-ovate, convex, black, shining, pygidium bright red; the head feebly and sparsely punctured; the thorax more clearly punctured, especially on the disk before the transverse punctures; the elytra, sutural stria well marked and continued along the base nearly to the humeral angle, dorsal area irregularly punctured, some of the punctures assume a linear arrangement. Beyond the hairy metasternum and a slightly increased breadth of the anterior tarsi there are no visible masculine differences; the legs are usually black, but frequently reddish.

Hab. Yuyama, Kiga, and Nikko.

Scaphidium incisum, sp. n.

Angustato-ovatum, nigrum, nitidum, supra punctulatum; ♂ tibiis antice inconspicue emarginatis.
L. $4\frac{1}{4}$–$4\frac{1}{2}$ mill.

Somewhat elliptical, black, shining; the head and thorax clearly, not thickly punctured, transverse punctures of the latter well-marked and similar throughout; the elytra with the sutural stria punctate, continuing as in the last species along the greater part of the base, dorsal surface clearly and evenly punctured, with little or no indication of linear arrangement; legs and antennæ black, male with enlarged anterior tibiæ, the enlargement being feebly emarginate on the inner edge; tarsi brownish; antennæ pitchy red or black at the base.

Hab. Miyanoshita, Nikko, and Mayebashi. Apparently scarce.

Cyparium sibiricum, Solsky.

Hab. S. Yezo, abundantly, and on the main island as far south as Chiuzenji, more rarely. One example in Higo.

L.—*Description of a new Transitional Form of* Ornithoptera *belonging to the Subgenus* Priamoptera. By ROBERT H. F. RIPPON.

IN the August number of the 'Annals'* I described a beautiful and most interesting new species of the genus *Ornithoptera* closely allied to *O. aruana*, Feld., which evidently linked the genus most closely with its section *Priamoptera*. I have now the privilege, by the courtesy of Mr. Elwes, of describing a still more important and interesting novelty discovered by Mr. Doherty in the Island of Talaut, which may ultimately throw much light on the phylogenetic history of the genus, inasmuch as it may be regarded as one of the transitional forms, some of which have probably long since perished, which would enable us to link together in a natural series all the many nominal species which we find it necessary to admit into the subgenus *Pompeoptera*, and even to suggest, on the side of the female at

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* 'Annals,' Aug. 1892, p. 193; also in part v. of my 'Icones Ornithopterorum,' where a plate of coloured figures is given.

least, a closer relationship with the *true Ornithoptera* than at one time might have seemed probable.

We owe a debt of gratitude to Mr. Doherty for the faithful and admirable work he has for a long time been doing among the islands and islets of the Sunda Straits and adjacent localities. In this respect he has been rapidly entitling himself to be regarded as a second Wallace. The novelty which is now before us appears to me to be one of the most useful contributions to the Rhopalocerous fauna which he has been enabled to send to us.

I have therefore much pleasure in dedicating this new species to him, partly at the suggestion of Mr. Elwes, and partly because I think it is right to give what honour we can to those who faithfully spend their health and energies in difficult regions of the earth, for the purpose of discovering those lovely things which furnish us with fresh materials for one of the most delightful studies, and with an increased knowledge of God's works.

Ornithoptera (*Priamoptera*) *Dohertyi*, sp. n.

♂. Primaries an intense silky black, almost like a burnished black, with a faint green gloss in certain lights, which gives it an exceedingly rich appearance. The grey discal rays which enclose the nervules are so obscurely represented as to be scarcely visible except when the light is transmitted from the underside. The veins are all well expressed, being somewhat lighter on the dark and much darker on the light parts of the wing; the costa is also of the same tint, especially near the apex when viewed opposite the light; the costal outline is nearly straight to two thirds of its length, or at the termination of the costal nervure, when it curves considerably to the apex, which is so much rounded as to pass insensibly into the posterior margin; the outline of the posterior margin curves somewhat irregularly, with an outward trend much greater in proportion at the termination of the second and third median nervules than at any other part, not excepting the apex; it is very delicately and equally sinuate along its entire outline, with very fine reddish-ochreous fringe-lunules between the veins as usual.

Secondaries entirely glossy black, slightly greenish or bluish according to the position in which they are viewed; the veins sufficiently defined in a lighter tint; the abdominal marginal sexual pouch or fold is a faintly redder black; the posterior margin regularly and sufficiently scalloped, and without the white fringe-lunules. Hence the entire upper surface of the wings is absolutely immaculate.

Under surface of primaries velvety or silky black, less dark and more glossy towards the posterior margin; within the discoidal cell, at the termination of the third *pseudoneurus*, are a few scarcely visible grey atoms; the discal grey rays enclosing the nervules are strongly defined in a slightly greenish grey, rendered darker by a graduation with black atoms towards the cell; the rays between the third and fourth subcostal nervules are only faint streaks of grey, and only one occurs on the upperside of the third median nervule; the posterior margin almost entirely outlined by the white fringe-lunules, which at the apex slightly encroach upon the costa; veins strongly defined. Secondaries a deep silky black; the abdominal fold or pouch browner, with a fringe of delicate hairs as long as the width of the pouch; the discoidal cell immaculate; between the first and second subcostal nervules is a subquadrate patch of yellow atoms; between the second subcostal and third median nervules a broad discal band of lemon-yellow, forming four subrectangular patches of unequal length, strongly divided by the nervules, the first broadly indented from the direction of the cell, sinuate without, the second indented outwardly and enclosing an elongate black spot, the third indented without and enclosing a slightly interrupted elongate black spot, which nearly divides the yellow area, the fourth lunate without and sharply indented above; viewed obliquely with a side light this yellow band becomes a rich emerald-green, not unlike the green of the typical *Ornithoptera*; the hind margin is without the ochreous fringe-lunules.

Head: antennæ black; eyes chestnut-brown; haustellum silky black. Prothorax with a crimson collar; thorax above velvety black, beneath deep black, with lateral crimson spots; legs black. Abdomen pale brown, bordered with piceous brown; the first segment entirely piceous brown, the subanal segment also of the same colour, margined with creamy white; the anal valves creamy white, with the usual dorsal black termination; laterally the abdomen is of a creamy ochreous white; subdorsal slightly yellower at its junction with the metathorax, more ochreous near the anal valve, the first and second segments well divided by black; the lateral black dots fairly large.

The space of wing enclosed by the two branches of the precostal nervure is more equal in width than is usual till it reaches its junction with the subcostal nervure, when, of course, it becomes narrower. This is really a very striking character, the nearest resemblance to which is found in the male of *P. hephæstus* so far as I can discover; it is also nearly as rectangular in the female.

Expanse of costa 69 millim.; width of upper wing 57; length of hind wing 44, width 31; length of abdomen or antennæ 31; of legs, first pair, femur 12, tibia 9, tarsi 12; second pair, femur 12, tibia 12, tarsi 15; third pair, femur 11, tibia 13, tarsi 15 millim.

♀. Primaries: costa equally arched but more rounded at the apex, the outline insensibly passing into the posterior margin, which is not so irregularly curved as in the male; inner margin nearly a straight line. Wings light fuscous brown; within the discoidal cell are faint atomic indications of grey markings somewhat like those of the female of *P. haliphron*; the grey discal rays very indistinct except those enclosing the first and second median nervules (which are fairly though faintly defined), broadly separated by the brown margins of the nervules; the *pseudoneura* are only just visible; posterior margin with whitish fringe-lunules. Secondaries slightly darker fuscous brown; within the cell a faint ochreous rufous-yellow spot close to the discocellular nervules; four very short narrow rufous-yellow discal marks, the first 6 millim. long, close to the second discocellular nervule, the second the same length from the cell, the space between the second discocellular and first median nervules broadly incurved and (on the right wing only) enclosing a small brown dot; the third 7 millim. long from the cell, indented two thirds its length, enclosing a brown spot (on the right wing); the fourth 5 millim. long from the cell, indented (on the right wing only about half the size); extremely faint indications of a submarginal band of small spots; the submedian area of wing is clouded pale reddish ochreous, meeting an anal, angular, ochreous, sublunate spot, from which two rays run partly up the abdominal margin; margin sufficiently scalloped, with ochreous fringe-lunules.

Under surface: primaries the same colour as above; the grey rays and discocellular markings similar but much broader, a brighter ochreous red at the outer margin, greenish grey towards the base and confluent between the second discoidal and second median nervules; the marks within the cell are formed of microscopic atoms, and are divided into three submarks—the first broad, one third of the cell in length, the second very narrow and divided by the second *pseudoneurus*, the third or lower one nearly as broad and long as the first and divided by the third *pseudoneurus*; the marginal fringe with a nearly continuous row of ochreous lunules. Secondaries same colour as above, but slightly darker; a large discocellular pale spot clouded with atoms close to the discocellular nervules; the discal marks corresponding with the four on the upper surface are much paler and extend much further down between the nervules—the first is partly pure and partly formed by atoms, the second is indented with brown, modified by atoms, the third much larger and with a long brown indentation, and the fourth very long, but so interrupted with brown modified by atoms as to form an ochreous ray close to the nervules extending nearly to the marginal border; outside the third median nervule is also an ochreous atomic ray close to the nervule, almost hastate, followed by a second longitudinal stripe extending lower down nearly to the outer margin; the submedian nervule and the abdominal margin have similar ochreous stripes as above, but more prominently developed; there is a broad submarginal band indicated by narrow ochreous stripes and cuneiform spots, so meeting and enclosing the brown areas between the nervules, especially from the second subcostal and third median, as to give them almost the appearance of arches, the bases of which are the fringe-lunules of the posterior margin.

Head: antennæ deep black; eyes chestnut-brown; haustellum black. Thorax and prothorax dark brown, with crimson collar; lateral crimson spots, and subdorsal with less black. Abdomen pale fuscous brown, with lateral borders of reddish ochreous; subdorsal the same, with strongly outlined or entirely fuscous brown segments; anal tuft dark brown.

Expanse of costa 82 millim.; width of upper wing 61; length of lower wing 51, width 45; length of antennæ or abdomen 31, of thorax with head 21. The legs, all but one, are absent from the specimen.

Hab. Isle of Talaut (*Doherty*). Feb. to March 1892.

Some examples of the female are entirely free from discal marks above, as in the male, and in one example more than half the under surface of the primaries is entirely fuscous white, the veins only being dark.

Setting aside the remarkable precostal character of the male, which allies it to *P. hephæstus*, the nearest affinity of the male is with *P. Plateni* on the upperside, appearing like an immaculate var. of that Philippine species. On the under surface of the lower wing the yellow marks suggest an approach to those of *haliphron*; the female also on the upper wing, and somewhat on the under surface, comes nearer to the *haliphron* facies*. The outline of the male primary wing is unlike

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* Since writing the above I have been able to compare the females with a female of *Priamoptera iris*, Röbers, and am struck with the resemblance of one or two examples of *P. Dohertyi* with the latter.

that of any other; nevertheless we have in this species a close ally of *Plateni* and possibly an old form from which perhaps several of the varieties of the *haliphron* and *helena* groups have been derived by differentiation—a transitional species I have long expected would be discovered. After awhile other transitional forms will, I hope, be found, and we may then be able to understand some of the geographical development history of the whole genus.

I am much indebted to Mr. Elwes for the cession of a large and interesting series of this novelty, the types of which, with several varieties, will occupy two plates in the sixth part of my 'Icones Ornithopterorum,' with extended information.

24 Jasper Road,
Upper Norwood, S.E.

LI.—*Note on* Apteryx Haastii.

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

Gentlemen,—In the February number of your Magazine Mr. H. O. Forbes answers my notes on *Apteryx Haastii*. I deeply regret that he considers I have been guilty of an indiscretion in writing about opinions which, although openly expressed, he never published in print, and I hope he will accept my full apology.

I must, however, in justice to myself answer his objections in full. In the first place he contends that, contrary to my statement, *Apteryx Haastii* has only been recorded from the South Island, and that in single specimens in localities only where *A. australis* and *A. Oweni* are found together. In reply to this I have to state that the first four specimens of *A. Haastii* I ever received were young birds of the size of *A. australis*, and were so distinct that I had at first thought they were a new species; but I now, since my last article, find they are not. These four birds were collected by a German botanist on Stewart's Island and were sent me by Sir Walter Buller. Then Sir Walter Buller sent me alive a young *Apteryx Haastii* without a locality; and, lastly, he sent me fourteen or fifteen specimens, all collected on the west coast of the North Island, among which were two live birds, male and female, and a chick and rotten egg, all dug out of one hole.

In addition to these I have notice of some *A. Haastii* sent to me lately by a man named Danneford, which also came from the North Island. Moreover, Professor Reichenow exhibited before the German Ornithological Society a specimen of *A. Haastii* from the North Island.

Mr. Forbes has stated further, in support of his theory, that the cæcum of *A. Haastii*, being different in the two sexes, was rather a sign of hybridity than otherwise. Unfortunately he has read my notes quite wrongly. I said:—"Another distinctive character will be found in the cæcum, which seems to differ not only in the two sexes, but also in all the various species of the genus." By this I meant to say that a further difference lay in the distinction of the cæcum in each species, not in the sexes, for, as I have proved, the male and female cæca are distinct in each species. Professor Owen was the first to describe this strange difference in his article on the anatomy of *Apteryx australis*, in the 'Transactions of the Zoological Society.' As regards my argument upon the size of the beak of *A. Haastii*, I never mentioned the subject of length; I can only say that as to length I have several *A. Mantellii* with longer beaks; but what I said was that, "though not so long as that of *A. maximus*, it is very much stouter even than that of the recently discovered extinct species." This is a fact, as my largest female *A. Haastii* has a beak nearly if not quite twice as large in circumference at the base as any known *Apteryx*.

Finally, I must reiterate the fact that not only have I found the cæca of Apteryges differ in the two sexes, but also most of the Struthionidæ present this difference; and I have to point out that the cæcum of the Emu (*Dromæus*) is about 3 inches long, while that of the much smaller *Rhea americana* is nearly 7 feet long, and *Apteryx Mantellii* has a cæcum 9 inches long, while in *A. maximus* it is barely 4 inches long *.

Walter Rothschild.

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* If, however, it should be proved, which I for one very much doubt, that the two specimens of *A. Haastii* described by Potts are hybrids, both South-Island, North-Island, and Stewart's-Island specimens of large grey *Apteryx* will have to be described as new species; for I know they come from districts where no *A. Owenii* have ever been found, and are totally unlike anything which could be produced by crossing.

LII.—*Contributions to the Development of the Tooth-Rudiments in Rodents.* By PAUL FREUND*.

In the autumn of 1890, at the suggestion of Prof. Born, I commenced to investigate the development of the dentition of various Rodents, with a view to discovering whether in the diastema between the fully developed teeth it was still possible to find remains of rudiments of such as had disappeared. It was only after making certain discoveries bearing upon the question that I learnt that a paper by MM. Pouchet and Chabry † contains a series of statements with reference to this subject. Nevertheless, when I have furnished a more precise critical comparison of the results of these authors with my own, it will be seen that what are really very material points have escaped their notice.

The dentition of the Rodents attracts attention in the first place owing to the great reduction in the number of the teeth. The largest number is found in the Leporidæ, which possess twenty-eight teeth, namely $i.\ \frac{2}{1}$, $c.\ \frac{0}{0}$, $m.\ \frac{6}{5}$, the smallest in the Muridæ, in which in the majority of cases the number is sixteen, namely $i.\ \frac{1}{1}$, $c.\ \frac{0}{0}$, $m.\ \frac{3}{3}$; while in *Hydromys* we actually find only twelve teeth ($i.\ \frac{1}{1}$, $c.\ \frac{0}{0}$, $m.\ \frac{2}{2}$). The incisors are always separated by a wide diastema from the molars or premolars, as the case may be. As further peculiarities we must regard the absence of the milk-dentition in many species and also the circumstance that the incisors invariably, and the molars usually, belong to the category of continually growing rootless teeth.

It is assumed by all authors who have written concerning the origin of the Rodents that the latter have been derived from forms with a fuller and, above all, more completely equipped dentition, and that consequently the reduction in the number and the disappearance of certain kinds of teeth, such as the canines, are phenomena of a secondary character, connected with the special adaptation of the dentition to a peculiar sort of food, which could hardly be turned to account without this modification of the teeth. In other words, the

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* Translated from the 'Archiv für mikroskopische Anatomie,' Bd. 39, pp. 525–554 (Bonn, 1892): from a separate impression communicated by Dr. Forsyth-Major.

† G. Pouchet and L. Chabry, "Contributions à l'Odontologie des Mammifères," Journal de l'Anatomie et de la Physiologie: Paris, 1884.

reduction in the number of the incisors (in the mandible there is always only one on each side, in the upper jaw there are two in the Leporidæ only, in all other cases there is likewise one) and the disappearance of the canines, and, at any rate, of a portion also of the premolars, are related to the modification of the persisting incisors to form chisel-like gnawing-teeth, by means of which the animals are able to consume even very solid vegetable food-substances, such as the bark of trees and grains, the latter of which possess an especially high nutritive value. It has already been demonstrated by numerous authors that the peculiarity of the continuous growth of the gnawing-teeth also belongs to the complete efficiency of the entire arrangement. The effectiveness of this form of dentition in the struggle for existence is at once evident from the great wealth of species possessed by the order Rodentia, the universal geographical distribution of its representatives, as well as the enormous number of individuals composing the various species. The latter phenomenon naturally results from the proverbial fertility of the Rodents; but this, as we know, is directly proportional to the abundance of food and the ease with which it is obtained. It is characteristic that the advantages in the struggle for existence, which are ultimately occasioned by the form of the dentition, are so great that Nature has almost entirely dispensed with the additional gift of other means of defence. The Rodents are among the most defenceless of Mammals.

Our views as to the reduction of the dentition in particular depend upon the conceptions which we have formed as to the phylogenetic derivation of the Rodents. A whole series of such conceptions, however, have already been formulated by various authors. The fullest and most recent treatment of this subject, which is based upon an exhaustive comparison of the dentition, of various parts of the skeleton, the urogenital system, and the mammary organs, is furnished by A. Fleischmann *.

Fleischmann is inclined to derive the Rodents from marsupial-like ancestors, with a complete insectivorous dentition. In his seventh chapter, which he terms a "Phylogenetic Sketch," he sums up his results as follows:—"In the organization of the Rodents two different stages are accordingly recognizable, which are full of meaning for the history of Mammals. On the one side many peculiarities are emphasized which are of functional importance in a lower stage,

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* 'Embryologische Untersuchungen von A. Fleischmann, Privatdocent in Erlangen,' ii. Heft.: A. "Die Stammesgeschichte der Nagethiere."

represented by the Marsupialia; on the other many conditions of form are approximated to the type of the higher Placentalia. The Rodents stand as it were as ancient monuments of a time which has long since disappeared, and unfold before us the representation of the modification which, perhaps as early as the Cretaceous period, elevated the Protheria into the condition of placental Mammals. Nevertheless the facts with which we are at present acquainted do not suffice to prove a direct relationship to the Marsupials. **It is only possible to maintain that animals very similar in their organization to the structure of the Marsupialia were the ancestors of the Rodents.** The forms of phylogenetic importance are not concentrated in one group, but are distributed over all four divisions of the Rodentia; for, in accordance with the special conditions of existence, with which we are still very imperfectly acquainted, certain organs have retained their primitive characters in one division, and others in another." In direct reference to our results in the case of *Lepus* I would also like to quote here the concluding sentence of the same chapter:—"As regards the Lagomorpha, it seems to me that the theory founded by Schlosser is established, namely that they did not branch off from the primitive stock simultaneously with the true Rodents, but that they have existed as placental Rodents only for a relatively short period."

In other respects Schlosser's admirable palæontological and general investigations* upon the organization and historical development of the Rodents have already been exhaustively discussed in Fleischmann's treatise.

Especial stress must also be laid upon the fact that, although certain of the herbivorous Marsupials possess a dentition which is in the highest degree similar to that of the Rodents (*Phascolomys* even has continuously growing incisors, and withal the dental formula $i.\ \frac{1}{1}$, $c.\ \frac{0}{0}$, $p.\ \frac{1}{1}$, $m.\ \frac{4}{4}$), Fleischmann nevertheless expresses himself very decidedly against a direct derivation of the Rodents from these animals. He writes:—"The herbivorous Marsupials do not stand in a closer phylogenetic relation to the Rodents, but are a peculiarly differentiated branch of the Metatheria. My object in minutely describing the dentition of various Marsupialia was merely to demonstrate that the reduction of an originally complete dentition in the herbivorous Diprotodontia occasions arrangements which are very similar to the dentition of the

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* M. Schlosser, "Die Nager des europäischen Tertiärs nebst Betrachtungen über die Organisation und die geschichtliche Entwicklung der Nager überhaupt": Cassel, 1885. 'Palæontographica,' 31 Bd. Dritte Folge, 7 Bd.

Rodents. Consequently, if in a branch of the Mammalian stem it is possible to recognize in actual examples the development of an upper and lower pair of incisors, accompanied by the loss of the rest of the incisors and the canines, it is also a probable assumption that in the ancestors of the Rodents a similar process occasioned an analogous result. In the group which was undergoing modification the adaptation of the cutting-teeth to their heightened function would have advanced further, since the rooted incisors attained a prismatic shape and the faculty of permanent regeneration."

Another view is supported by Cope *, who derives the Rodents from the Bunotheria, as represented by the suborder Tillodontia, which, while possessing a more complete dentition, exhibit a decided rodent-like formation of individual incisors.

With reference to the results of our embryological investigations, it seems worth remarking that, according to this derivation, the large gnawing-teeth of the existing Rodentia would correspond to the second incisors of what Cope supposes to have been their ancestors, since in the latter the first incisor is already rudimentary and small, while the second is developed into the gnawing-tooth.

An altogether separate position is taken up by Baume † in his speculations.

This position is in the first place based upon the fact that this author is desirous of regarding continuously growing teeth as the prototypes of Mammalian teeth in general. In forming this conception he relies upon the view that the continuously growing rootless tooth is of relatively simpler construction. At the same time he considers that the organization of such teeth is adapted for the production of a mass of tooth-substance. This property is likewise considered by Baume to be of a primitive character, since, as he urges, in the whole animal series we may recognize the law of a progressive reduction in the formation of tooth-substance. Moreover, according to Baume, with the exception of the Rodentia, animals with continuously growing teeth belong to old groups, the still existing representatives of which are perhaps on the way to extinction. It is evident that by

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* Cope, "The Mechanical Causes of the Development of the Hard Parts of the Mammalia," Journ. of Morphology, vol. iii. 1889 (Boston). I was unfortunately unable to consult the actual original communications of this author upon the present subject in the 'American Naturalist' of 1883–84 and the 'Report of the United States Geological Survey.—Tertiary Vertebrata,' 1885.

† R. Baume, 'Odontologische Forschungen, Theil i.—Versuch einer Entwicklungsgeschichte des Gebisses': Leipzig, 1882.

adopting Baume's view we avoid a difficulty of the following kind: if we derive continuously growing rootless teeth from rooted teeth with limited growth, we are compelled to assume a repetition of the same process (convergence) in representatives of the most widely different families, which have no direct connexion whatever one with another; for, according to Baume, we find continuously growing teeth "in a motley series among the Carnivora, Cetacea, Prosimiæ, Multiungulata, Sirenia, Ruminantia, Rodentia, and Marsupialia. They are, as appears from the above comparison, widely distributed, but also very scattered, when relationships are considered. The various representatives occupy a number of isolated positions."

Mahn * and Fleischmann have disputed the justice of Baume's assumptions, adducing weighty arguments in opposition to them.

Moreover this conception of Baume's is in accordance with the other peculiar views advanced by this author, the most prominent of which is his theory that the milk-teeth should not be regarded as constituting a special dentition. According to this idea we should only get a pseudo-diphyodontism in Mammals. The milk-teeth would belong to the same series as the permanent ones; they would merely be feebler structures, developing more quickly. The stronger (permanent) teeth develop more slowly according to Baume, but afterwards displace the quickly developed feeble (milk-) teeth. This is not the place for the elucidation of the question as to what are the facts of comparative anatomy and embryology upon which Baume bases his conception. I still have to refer incidentally in the special portion of this paper to the results of Baume's investigations into ontogeny. At any rate, even Baume coincides with all other authors in assuming that the dentition of the Rodentia has arisen by means of reduction from a richer and completer series of teeth.

How extensive the reduction must be supposed to have been is evident from a comparison of the existing dental equipment of the Rodents with the fundamental type of the dentition of the Eutheria, as the latter is formulated by Schlosser † after Oldfield Thomas. According to the theory referred to, the ancestors of the Placentalia would have possessed five incisors, one canine, four premolars, and four molars, though it must certainly be remarked that such an

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* R. Mahn, "Bau und Entwicklung der Molaren bei *Mus* und *Arvicola*," Morphol. Jahrb. Bd. xvi. Heft 4.

† M. Schlosser, "Ueber die Deutung des Milchgebisses der Säugethiere," Biol. Centralbl. Bd. x.

abundance of teeth is not found to be realized in any recent or known fossil form.

The question now arises as to how far traces of the process of reduction, and remnants of the teeth which have disappeared, still admit of embryological demonstration in the case of the Rodents.

This query naturally further divides itself into three in the following manner, each of which questions must be separately investigated for the upper and lower jaw :—

(1) Since, with the exception of the premaxilla of the Leporidæ (in which two teeth are present), the recent Rodentia possess only one incisor, we are confronted with the question whether vestiges of the other incisors which have disappeared are traceable in the embryo. Herein, especially in connexion with the views of Cope which have been mentioned above, regard must be paid to the position of possible embryonic rudiments with reference to the large incisor. Are the rudiments situated on the inside or outside of the latter? And is this consequently to be considered as *i.* 1 or as *i.* 2?

(2) Do vestiges of tooth-rudiments exist in the diastema? This question divides itself, according to the three stages which are observable in the embryonic development of teeth, into three subquestions :—

(*a*) Do we find only a dental fold (Zahnleiste) in the diastema?

(*b*) If such a structure is present, are enamel-organs formed upon it?

(*c*) Is enamel produced within the enamel-organs, and dentine by the papillæ?

In the event of (*b*) and (*c*) being answered in the affirmative, this supplementary question arises:

Are the tooth-rudiments which are observed connected with the incisors or the premolars, or do both conditions occur?

(3) Since in the Rodent series the number of the molars descends from 6 (in the upper jaw of *Lepus*) to 3 in the case of the Muridæ (in *Hydromys* even to 2), in forms with a reduced number a search would also have to be made for remnants of the molars which have been lost. It is clear that this task may partly coincide with one subdivison of the foregoing question (rudiment at the posterior end of the diastema). I wish to mention at once that in the present paper I have not devoted any special attention to this third question. Since the development of the molars in the Muridæ has been closely studied by Mahn under Fleischmann's direction, and since that author says nothing about rudiments of the vanished molars, which certainly would not have escaped his notice,

such an investigation seems at the very outset to offer but few prospects of success.

The material investigated by me is derived from embryos of *Lepus cuniculus*, *Sciurus vulgaris*, *Cavia cobaya*, *Cricetus frumentarius*, *Mus decumanus*, and *Mus musculus*. My methods consisted in the preparation of continuous series of sections through the heads of embryos according to well-known precepts. In particular I made use of the *technique* introduced by Prof. Born in the Breslau Anatomical Institute, as described by himself in his paper entitled "Noch einmal die Plattenmodellirmethode" *.

Plate-models were prepared of the most important stages. These naturally contained the epithelial tooth-rudiments, as well as the epithelium of the oral cavity from which they had proceeded; it is evident that Mahn (*loc. cit.*) worked in a precisely similar fashion.

I will take first the two species in the investigation of which positive results have been obtained, i. e. *Lepus* and *Sciurus*. The remaining forms, in which, in the sense of the queries which we have propounded, nothing was discovered, can subsequently be dismissed in a few words.

LEPUS.

With reference to this form a series of statements are contained in Pouchet and Chabry's paper (*loc. cit.*), which it is necessary for me to cite, since I have partly to confirm, partly to amplify, and partly to refute them. The French authors confirm the older observations, that in the premaxilla of the Rabbit three larger incisors are formed on each side, which, however, do not stand side by side, but one behind the other. The second of the series are deciduous, and drop out shortly before or shortly after birth. The *i.* 3† are formed much

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* Zeitschrift für wissenschaftliche Mikroskopie, Bd. v.: Braunschweig, 1888. In this paper Prof. Born writes as follows:—"As is well known, the essence of the plate-model method is that from each of a series of sections of equal thickness the parts which are to be modelled are drawn upon plates, which are exactly so much thicker than the section as the sketch is larger than the original. The parts drawn are cut out and stuck one upon another; in this manner a plastic reconstruction is obtained of the structure under investigation" (p. 445). .... "Formerly I scratched the outlines of the section upon prepared (cast) plates. I now use plates of waxed paper, in accordance with Strasser's suggestion, and after drawing upon the paper, I cause this to be thickened with wax until plates of the desired thickness are obtained" (p. 446).

† For convenience' sake here and subsequently *di.* 2 (according to the customary nomenclature) is designated shortly *i.* 2, while the permanent *i.* 2 is termed *i.* 3.

later than *i.* 1 and *i.* 2. From my own experience I have nothing to add to these statements, since the rudiment of *i.* 3 (the permanent *i.* 2) in the largest embryo examined by me (10 centim. in total length) was but little further developed than in the embryo from which fig. 20 of the French authors is derived. The rudiment of this tooth was represented by a clavate enamel-organ, indented only by quite a flat papilla, and situated ventrally and posteriorly to the greatly developed deciduous *i.* 2. As stated by Pouchet and Chabry, *i.* 2 and *i.* 3 lie in one and the same alveolus.

As Fleischmann convinced himself from the examination of transverse sections, the *di.* 2 are enamel-crowned teeth with two roots of dentine.

In the mandible the rudiment of only one large incisor is formed. In addition to this, however, Pouchet and Chabry discovered in *Lepus* two new deciduous teeth, which are situated in both jaws in front of the large *i.* 1. They found these teeth in embryos measuring from 28 to 45 millim. in length, and in a rudimentary condition, to which nothing analogous is known in other Vertebrates. The abridged account of their discovery runs somewhat as follows:—In embryos measuring from 28 to 45 millim. and something over in total length, there is found in front of the well-developed enamel-organ of the large incisor, and in direct connexion with its anterior face, an epithelial mass, which, in a cavity which is completely closed towards the exterior, contains a thimble-shaped cusp of dentine. The innermost columnar cells of the epithelial sac stand directly upon the surface of this cusp, and its pulp-cavity is filled with a certain number of blood-corpuscles and embryonic cells. The enamel-organ (for the epithelial sac can be considered as nothing else) of this dentine cusp is distinguished, according to the French authors, on the one hand by its compact texture (the enamel-pulp is absent), and on the other by the fact that it completely surrounds the cusp. The enamel-organ is connected by a cord of epithelium with the posterior side and the lower border of the sunken epithelial wall (" mur plongeant "). (Such is the term bestowed by these authors upon the sunken epithelial masses, which are found in many embryos in the region of the future groove between the lip and the alveolar margin. Projecting masses of epithelium, to which the authors apply the term " mur saillant," correspond approximately to the thickenings of the epithelium of the oral cavity at the edge of the jaw, which Germans call the jaw-wall [Kieferwall].)—Our cusp of dentine disappears long before birth, since it is either absorbed or drops out. According to Pouchet and

Chabry the enamel-organ of the large incisor is also connected by a cord of epithelium with the *mur plongeant*, but with its posterior and upper border. The authors referred to found a similar little rudimentary tooth in the upper jaw only in embryos which measured not less than 32 to 40 millim. in length. "It lies immediately in front of the large incisor, and its tip appears in the midst of the epithelium of the *mur plongeant*" (fig. 21).

The earliest stages which I was able to examine thoroughly consisted of embryos of *Lepus cuniculus* measuring 15 millim. in total length, of which the head occupied 9 millim. For earlier ones I had at my disposal only the series of sections from an embryo with a head 6 millim. in length. Since this shows only the dental fold, which is apparently continuous in the upper jaw, but in the lower one on the contrary is interrupted behind the region of the incisors, while the enamel-organs are as yet entirely absent, I shall defer the investigation of these youngest stages until I have more abundant material at my disposal.

First of all I deal with the region of the incisors in embryos with heads measuring somewhat more or somewhat less than 1 centim. The length of these embryos from the crown of the head to the root of the tail, which, for reasons which will be readily understood, is much more variable, fluctuates between 1·5 and 3 centim. Fig. 13 * gives a representation of the model which I have prepared of the epithelium of the oral cavity, with the tooth-rudiments of the upper jaw of the right side, of an embryo measuring ·9 centim. in cephalic length and 2·1 centim. in all; the model is seen from above and somewhat from outside; I have not figured a second model showing the rudiments of the incisors in the upper and lower jaws of an animal of about the same size.

In the lower jaw the rudimentary tooth discovered by Chabry and Pouchet may be seen. Fig. 1 gives a distinct view of this, from which it appears that the enamel-organ of the tooth is not closed on all sides, as asserted by Chabry and Pouchet, but is open on the underside. Through the aperture a richly nucleated pulp enters the interior of the tooth. The centre of the pulp is occupied by a wide blood-vessel, while its peripheral cells form a well-developed layer of odontoblasts, which has already secreted a solid hook-shaped cap of dentine. The latter, in the preparation upon which the drawing was based, has withdrawn a little from the well-developed enamel-epi-

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* The figures referred to in this paper will be found in vol. 39 of the 'Archiv für mikroskopische Anatomie.'

thelium. In short, apart from the absence of enamel, it is a thoroughly typical representation of a small tooth-rudiment, such as we are otherwise wont to find in lower Vertebrates. The connective cord, which unites the enamel-organ of the rudimentary tooth with the epithelium of the oral cavity, actually extends with its anterior end, as stated by the French authors, as far as the posterior circumference of the *mur plongeant*, which is here but little developed. Further backwards, however, this connective cord proceeds, as is shown in fig. 1, from the unthickened epithelium of the oral cavity. Moreover, we see from the figure that a strong epithelial projection, which is directed inwards, starts from the spot where the connective cord passes into the actual enamel-bell (Schmelzglocke). This arrangement is repeated more or less decidedly in each section. According to the customary conception the tract α–β in fig. 1 would have to be regarded as the "dental fold" ("Zahnleiste"), on the outer side of which, close above the end without a neck, the enamel-organ of the rudimentary tooth would be situated. Whether this mode of interpretation is here correct, can only be determined by the study of younger stages, which I am reserving to myself. Now the enamel-organ of the large incisor of the lower jaw is directly connected with the posterior side of the enamel-organ of the rudimentary tooth; in the same manner the cord which connects the enamel-organ of the rudimentary tooth with the epithelium of the oral cavity is posteriorly prolonged directly into the similar connective cord of the enamel-organ of the large incisor. If, as has been indicated above, we regard this cord as a dental fold, this continuity of the dental fold from one enamel-organ to the other would be nothing unusual, —on the contrary, it is in accordance with the general rule. The direct connexion, however, of two enamel-organs, as, moreover, also shown with great distinctness in fig. 19 (longitudinal section) of Pouchet and Chabry, is unusual. The enamel-organ of the permanent incisor is still at a very low stage of development. It is a lumpy epithelial mass, which on the posterior side appears somewhat flattened and indented. This shallow hollow subsequently deepens into the bell of the enamel-organ, which is open towards the rear. In the rudiment of the large incisor no trace of tooth-substance is yet developed.

Behind the large incisor the dental fold in the lower jaw entirely ceases. In order to dispose of this question at once, it may be mentioned that in the case of *Lepus*, in this, as in all subsequent stages, an absolute diastema is found in the lower jaw between the incisor and the molars, in which distinct vestiges of a dental fold can never be detected.

Now as regards the incisors of the premaxilla in rabbit-embryos of about 1 centim. in cephalic length (*cf.* fig. 13): contrary to the statements of Chabry and Pouchet, the rudimentary tooth in the premaxilla is also already completely developed in embryos measuring 1 centim. in cephalic length, and about 2 centim. in all. As is shown in fig. 13, it is situated upon the epithelium of the oral cavity close behind the *mur plongeant*, which is still but little developed, in such a manner that a special connective cord between its enamel-organ and the oral epithelium cannot be distinguished. The enamel-organ is longer than in the lower jaw; the longitudinal axis appears to be directed obliquely upwards and outwards. At the upper end, displaced a little towards the front, we find the very narrow aperture, surrounded by a swollen margin, which leads into the interior of the pulp-cavity. The solid dentine tooth is developed just as beautifully as in the lower jaw. Owing to the absence of a special connective cord, the rounded tip of the very long tooth is separated from the surface of the epithelium of the oral cavity only by a few layers of cells. In the upper jaw also the enamel-organ of the rudimentary tooth is in direct continuity with that of the large incisor. In the model it is easy to recognize the peculiar conditions which are presented by the attachment of the first large incisor to the epithelium of the oral cavity,—conditions which can hardly be understood from the examination of sections, and to which it is only with difficulty that justice can be done in description also (in the figure, too, they can be seen but imperfectly). For behind the spot at which the enamel-organ of the large incisor is attached, the roof of the oral cavity bulges out downwards in the form of a step. (A similar step follows further back at the spot at which the enamel-organ of *i.* 2 is attached.) Moreover, the connective cord of the enamel-organ of the large incisor has a peculiar shape; for it consists of two plates, one placed transversely, the front of which, like the greater portion of the enamel-organ itself of *i.* 1, is fused with the enamel-organ of the rudimentary tooth, and another in the shape of a sagittal plate, attached at right angles to the inner edge of the former, and prolonged backwards as far as the enamel-organ of *i.* 2. In the case of the latter tooth the same conditions are repeated. We can also express the facts by saying that the connective cords, which unite the enamel-organs of *i.* 1 and *i.* 2 with the epithelium of the oral cavity, are hollowed out from behind and somewhat from inside. The connective cord of the first incisor is fused in front with the enamel-organ of the rudimentary tooth, and behind passes into the connective cord of *i.* 2, while, as we shall see, the latter is prolonged backwards into the dental fold of the diastema. This, together with the steps, produces, as has already been stated, highly complicated appearances. What we have to remember is, that the enamel-organs of *i.* 1 and the rudimentary tooth are in direct continuity, while *i.* 1 and *i.* 2 are united by a structure which may well be regarded as a dental fold. The epithelial mass of the enamel-organ of *i.* 1 itself is lumpy, and when seen from the upper side behind somewhat flattened and indented. The margins of this hollow subsequently become more decidedly elevated, and so assume the characteristic bell-shape. The enamel-organ of *i.* 2 is, as may be seen from fig. 13, in not nearly so developed a condition.

We will here at once mention the changes which take place in the region of the incisors in subsequent stages. With reference to the lower jaw we have to observe that the sunken epithelial wall (*mur plongeant*), which marks out the subsequent groove between the lip and the alveolar border, becomes much more strongly developed and extends further backwards. In the foremost sections it appears as a bifurcate and deeply sunken epithelial mass, which to a certain extent ensheaths the anterior end of the Meckelian cartilage and the covering bones lying thereon. On the inside of the epithelial mass is attached the common connective cord of the enamel-organs of the rudimentary tooth and of the large incisor. The latter in embryos measuring 1·5 centim. in cephalic length and about 4 centim. from crown to rump, already assumes the well-known bell-shape, in the manner which has been indicated above. Since the size of this bell, which is enormously expanded behind, and within which the tooth develops in the usual way, by far preponderates, it now appears as though the tip of the rudimentary tooth were implanted in the cord connecting this great bell with the epithelium of the oral cavity, while only the lower end of the tooth, surrounded by its enamel-organ, projects freely downwards in front of the great bell. The conditions which are now present are consequently similar to those which are shown in fig. 14 in the case of the squirrel. The rudimentary tooth is indeed far behind the large incisor in growth, but nevertheless in older animals, *e. g.* in rabbits measuring about 2·5 centim. in cephalic length and *circa* 7 centim. in all, it has decidedly increased in size in comparison with the younger stages. Its pulp-cavity is never closed towards the exterior, as is stated by Chabry and Pouchet, but always remains in connexion with the surrounding mesoderm, though it is true not in the simple manner which is seen in fig. 1. In larger rabbits the size of the rudimentary tooth appears decidedly diminished, as though it were in process of absorption. In still later stages I could no longer find any trace of it, although I am unable to make any precise statement as to the manner of its disappearance, any more than Chabry and Pouchet were able to do.

In the premaxilla the changes are precisely similar to those in the lower jaw. A strong sunken epithelial wall is formed, which indicates the region of the subsequent cleft between the two halves of the lip and the anterior end of the jaw. It consequently appears simple in the foremost sections, and bifurcate further back. One half of it is to be seen in fig. 2, and a longitudinal section in the combination-picture shown in fig. 3. In this enormous epithelial mass the anterior step on the roof of the oral cavity, as described above in the younger stage, completely disappears. On the inside of the lateral tip of this epithelial mass is situated, as is shown in fig. 2, the enamel-organ of the rudimentary tooth (fig. 2 belonged to a series through the head of a rabbit embryo measuring 5·1 centim. in all and 2·3 centim. in cephalic length). The enamel-organ of the first incisor develops into a huge bell, which is open behind, and, in accordance with the conditions previously described (*cf.* figs. 2 and 13), the rudimentary tooth now appears to lie in the cord connecting this bell with the *mur plongeant*. Owing to the development of the *mur plongeant* the tip of the tooth has naturally penetrated very deep down. The combination-picture fig. 3, which is constructed from longitudinal sections through the head of a rabbit embryo of the same size as that of fig. 2, shows these conditions perhaps most distinctly.

The histological conditions of the rudimentary tooth may be recognized in fig. 2; its dentine casing appears broken through on the outside in this figure. The connexion between the pulp and the mesoderm takes place through this breach, not directly however, but in a very complicated fashion, since the enamel-organ appears as if cleft by strands of connective tissue, producing conditions of which the detailed description belongs to another place. In the same way I have no intention of entering into a discussion of the histological conditions in the enamel-organ of the large incisor. I would merely refer the reader once more to fig. 2, which in some degree exhibits the peculiar penetration of vascular outgrowths into the outer wall of the enamel-organ, which has already been dealt with by so many investigators. The rudimentary tooth of the premaxilla persists for about as long as that of the lower jaw. I am at present unable to say anything as to the manner of its disappearance. In embryos with a cephalic length of 1·7 centim., and measuring 4·5 centim. in all, the dental fold between the first and second incisors was still present, although it is true that its connexion with the oral epithelium had almost everywhere disappeared. The enamel-organ of *i.* 2 had become distinctly campanulate. In an older series the dental fold between the two large incisors had already entirely disappeared, although in the model of the stage in question the step upon the palate was still to be seen, to the anterior margin of which the cord connecting the enamel-organ of *i.* 2 with the oral cavity was previously attached, while, in all probability as a remnant of this connexion, we still find an epithelial projection jutting out slightly into the connective tissue.

While up to this point, with the exception of immaterial modifications, I was able to confirm the statements of Chabry and Pouchet on the subject of the development of the teeth in the rabbit, the results at which I have arrived with reference to the diastema in the upper jaw are quite different from those obtained by the French authors. The latter assert that in the rabbit the dental fold is entirely interrupted in the diastema in both jaws. As I have already mentioned, I can confirm this statement as regards the lower jaw. In the upper jaw, on the contrary, I find the dental fold already typically developed, in the youngest stages investigated by me (measuring about 1 centim. in cephalic length and from 2 to 3 centim. in all), throughout the entire length of the diastema between the rudiments of the incisors and those of the molars. A good representation of this is given in fig. 13. The dental fold is situated in precisely the same spot as that in which it is found in mammals with a complete dentition, *i. e.* internally to the furrow made by the approximately horizontal roof of the mouth in bending round into the perpendicular mucous membrane of the cheeks. The spot at which the dental fold is attached is in the region of the diastema, as in that of the rudiments of the molars, somewhat depressed, towards a protuberance of the surface of the palate situated on the inner side of it (jaw-wall?). It is perhaps expedient, in addition to the measurements, to give yet other characteristics of the stage in which the fold is found to be fully developed. The stage is that in which the closure of the palate has just been completed, in which we still find distinct remains of epithelium in the perpendicular palatal suture, and in which, in the horizontal palatal suture (between the nasal septum and the hard palate), a characteristic arrangement of the connective-tissue elements is still evident; by this, however, it is in no way intended to imply that the epithelial fold is not already present before this stage when the palatal cleft is open, and subsequently when the palatal suture has disappeared. My series furnish me with sufficient proofs of both cases. I merely wished to characterize the stage at which the fold appeared to me to be most developed. The epithelial fold at its anterior commencement is very shallow and inconspicuous, as it is also reproduced in model 1, and is connected with the enamel-organ of *i.* 2. In the region of Stenson's canal it is sometimes so inconsiderable that it is with difficulty detected. Behind this it speedily increases in height, and attains its greatest elevation at the transition into the rudiments of the molars. In the sections it appears as an epithelial cord, which proceeds from the epithelium of the oral cavity, inclined somewhat obliquely inwards, and is buried in the mesoderm. In the neighbourhood of the oral epithelium it appears narrow, having a breadth of only two very low rows of cells; the sunken end is thickened into a button-shape, owing partly to the increased height of the peripheral cells and partly to the intercalation of several cells in its interior. The form and size naturally vary very considerably according to the direction of the section and other accidental circumstances. Fig. 4 gives a representation of the epithelial fold in a series in which it appears particularly broad. In the other series it looks decidedly more slender and longer. In the section figured (fig. 4) the length of the epithelial depression amounts to about 100 μ, the breadth of the thick end to about 60 μ, and that of the narrowed neck to 30 μ. In the series from which the model shown in fig. 13 is constructed, the height of the epithelial fold at about the middle of its length amounts to nearly 120 μ, the breadth at the thickened end only to something over 20 μ, and at the narrowed neck only to about 10 μ.

Even in an embryo measuring 11 millim. in cephalic length and 34 millim. in all, but much more distinctly and much more extensively in an older one of 17 millim. and 44 millim. respectively, the dental fold in the diastema exhibits a remarkable modification. At first only for a limited space, but in the older embryo almost throughout its entire length, the neck of the epithelial fold appears broken through by the mesoderm. The appearances in this connexion are precisely similar to those seen in other places, where a strand of epithelium is displaced by the adjacent connective tissue. The breach sometimes affects only the portion beneath the button-shaped end, so that a small cone is attached to the oral epithelium, followed by connective tissue, in the arrangement of the cells of which we can still frequently trace the direction of the epithelial cord which has disappeared. Deep down we then see the severed thickened end as a circle filled with epithelial cells, which is distinguished by the fact that, like other epithelial remnants undergoing degeneration in the same way, it takes up carmine very freely, and consequently appears of a dark red colour. It is clear that this process is the same as that also undergone by the dental fold in mammals with a complete dentition, after the enamel-organs have been formed and constricted off from it. The dental fold in the diastema of the rabbit, however, perishes without ever having produced enamel-organs. In an embryo rabbit 23 millim. in cephalic and 51 millim. in total length every trace of the fold has disappeared in the anterior portion of the diastema; but in the posterior portion, on the contrary, in the neighbourhood of the molars, there appears in each section at the same spot in the connective tissue of the palate a small red circle, which I am inclined to regard as the last vestige of the dental fold. My reasons for doing so are the following:—In the first place, it is found in the posterior portion of the diastema in every section at the same spot, and this spot, so far as I can see, corresponds to that at which the epithelial fold is found in younger stages. Secondly, in the connective tissue there frequently proceeds from the red spot to the oral epithelium a kind of cord of cicatricial tissue, *i. e.* a clear streak, in which we find but few nuclei, or none at all, while at the edges of it the nuclei are closely packed. Thirdly, the epithelial circle can be traced as far as the dental fold of the first premolar, though I am unable to assert with absolute certainty that a direct connexion exists. If my interpretation is correct, it would result therefrom, that the dental fold in the diastema in the rabbit disappears from in front backwards.

With regard to the rudiments of the molars in *Lepus cuniculus*, I have no special statement to make. In fig. 13 we see only three, and these still in a very undeveloped condition: the enamel-organs have the shape of flat shells. Another model, which is not figured here (prepared from a series of longitudinal sections through the head of a rabbit embryo 2·3 centim. in cephalic and 5·1 centim. in total length), shows the rudiments of five molars. In the second and third we find the characteristic bell-shape, with the projections directed towards the pulp. Nos. 1 and 4 are less developed; the fifth rudiment appears in the form of a button-shaped epithelial thickening, with only quite a shallow depression, at the posterior end of the dental fold.

SCIURUS.

Of this very interesting form, as it proved to be, I succeeded, in spite of a considerable expenditure of trouble and expense, only in obtaining one pregnant female with seven embryos. However, I reserve to myself the working out of older and younger stages, since I have at any rate learnt the way in which these may be obtained with certainty next year. Fortunately the stage which I have before me corresponds fairly accurately with that to which the most important statements of Chabry and Pouchet refer. Since I differ from them very considerably, it will be well to give a summary of the statements of the French authors, which are somewhat difficult to understand. They run as follows :—" The dental fold commences in the upper jaw at the level of the incisors, and extends to beyond the molars. . . . In front of the canals of Stenson the dental fold is entirely wanting. . . . In the mandible the dental fold is continuous throughout the entire extent of the diastema."

Now follows a sentence which does not seem quite intelligible after what has gone before. It runs :—" Consequently the dental fold in all Rodents which we have studied is composed of two halves, which are not united in the middle. In the squirrel in particular the incisors arise from the same epithelial invagination (involution) as the molars."

According to what was previously stated, this would be correct only for the lower jaw. For in the upper jaw the dental fold is said to be completely wanting even before the canals of Stenson.

The explanation of the figures shows that the statements of Chabry and Pouchet refer to embryos of the length of 4 centim. The embryos studied by me were 2 centim. in cephalic length and 4·7 centim. in all, and were consequently only slightly larger than those examined by the French authors.

The following are the results which I obtained :—

(1) Like the rabbit, the squirrel possesses in front of the large incisor a rudimentary tooth, which seems to have been overlooked by Chabry and Pouchet.

(2) There is found in the lower jaw, in the diastema between the incisors and molars, and extending only for a very short space, about as far as may be seen in fig. 15, in continuation of the dental fold of the incisors, a small epithelial cord, which is detached from the epithelium of the oral cavity, and is to be regarded as a remnant of the dental fold. In the whole of the large space behind this, as far as the molars, no

trace of it can be detected. Whether we may assume that in the only slightly younger stages which were investigated by Chabry and Pouchet, a complete dental fold is, as stated by these authors, present throughout the entire diastema of the lower jaw, is a question which I must postpone until I have more ample material at my disposal. I do not think it probable that it is so.

(3) In the upper jaw very extensive remnants of the dental fold are found in the diastema. The fold is not once wanting in any section from the incisor to Stenson's canal: compare figs. 8–10, and the model (fig. 14). In most places the epithelial cord is detached from the epithelium of the oral cavity, in others it is connected with it. It frequently appears to lie parallel to the surface of the palate; the nuclei of the connective tissue are disposed in a regular concentric arrangement around the epithelial remnant. This is therefore directly contrary to what is stated by Chabry and Pouchet.

Behind the orifice of Stenson's canals we find for a space no vestige of the epithelial fold: then it is present in certain sections once more, or in its place there appears a kind of cicatrix in the connective tissue. Even before the middle of the space between the orifices of the canals of Stenson and the first molar, we observe a remnant of the epithelial fold as an element which is again regularly visible in every section. At the posterior end it is easy to distinguish the way in which this remnant of the dental fold of the diastema passes into the dental fold of the first molar. It may further be remarked that in this tract also there is much variation; for the epithelial cord may appear larger or smaller, perpendicular or bent round, connected with the epithelium of the oral cavity or isolated. After this discovery it appears scarcely open to doubt, that in younger stages of *Sciurus* the diastema in the upper jaw is traversed by a continuous dental fold, precisely as in the case of *Lepus*.

(4) On the outer side of the dental fold in the diastema there are situated two little enamel-organs with distinct papillæ,—one close in front of, and the other in the plane of a transverse section through, the orifices of the canals of Stenson (*cf.* model, fig. 14). These two enamel-organs naturally lie one close behind the other. In both the aperture of the enamel-bell is directed forwards and upwards. The anterior of these two enamel-organs is the better characterized as such, in that it contains enamel-pulp (*cf.* fig. 7). But that the posterior rudiment is also of the nature of an enamel-germ (*cf.* fig. 10) is scarcely open to doubt. It is curious that in their fig. 26, MM. Chabry and Pouchet have given a perfectly

characteristic representation of the posterior of the two rudiments (the section also passes through the region of the orifice of the Stenson's canal): compare for this purpose my fig. 10. But according to the explanation of the figures they interpret the rudiment quite wrongly as that of the large incisor, which, as a glance at the model, fig. 14, will show, is much further developed, and besides this also has quite a different position.

It now remains for us to make more special observations with reference to certain of the above four paragraphs.

The dental fold upon which in the lower jaw the enamel-organs of the rudimentary tooth and of the large incisor are situated (*cf.* for this figs. 5 & 6, and model, fig. 15) proceeds from the commencement of a peculiar *mur plongeant*, which envelops as a deep case the anterior end of the Meckelian cartilage together with the superincumbent covering-bone. It is precisely the same formation as that described and figured by Chabry and Pouchet for the rat. Together with the epithelium of the oral cavity, it appears in a median transverse section as a closed circular epithelial arch, in the interior of which the dental rudiments, the bone, and the cartilage are contained. Upon the surface of the mucous membrane of the oral cavity, the spot from which the epithelial fold and beside it the *mur plongeant* proceed is distinguished by a groove. For posteriorly the epithelial fold ceases to be in continuity with the epithelium of the oral cavity (*cf.* model, fig. 15). That from the fold an epithelial cord runs backwards for a short distance has already been mentioned, and may be seen from the model. Now on the outer side of this epithelial fold the enamel-organs of the rudimentary tooth and of the large incisor are attached close together, each by means of a long neck, in such a way that only the somewhat clavate end of the epithelial fold projects a little further downwards and inwards than this point of attachment. For, as is shown both by the figures and the model, the neck of the rudimentary tooth is a particularly elongated structure, which reaches so far downwards and backwards, that the enamel-bell of the rudimentary tooth comes to lie beside the Meckelian cartilage (*cf.* fig. 6). Neither the neck of this enamel-organ, the stouter and more massive one of the incisor lying behind it, nor lastly also the dental fold itself have smooth outlines; on the contrary, they are beset with projections and depressions of the most varied kind (*cf.* for this figs. 5 & 6), so that in many places the appearance presented reminds us of that of the proliferating rudiment of a gland, or still better of that of a carcinoma.

The opening of the enamel-bell of the rudimentary tooth is, like that of the large incisor, directed backwards. Within it we do not find, as in the case of *Lepus*, a well-formed tooth of dentine, but a small, inconsiderable, almost solid dentine cusp, into which from the inner side only a narrow cord of connective tissue enters. This cusp, too, appears to be no longer enveloped on all sides by epithelium. With reference to the neck of the enamel-organ of the incisor, which follows after it, there is nothing more to be said than that at its starting-point from the dental fold it is broadly fused with the neck of the enamel-germ of the rudimentary tooth.

The position of the germ of the rudiment in the upper jaw is explained by model fig. 14. We observe that it is situated in front of the enamel-germ of the large incisor. The enamel-germ of the rudimentary tooth of the upper jaw is likewise attached to a long neck, which passes obliquely upwards and unites with the massive neck of the large incisor of the premaxilla. Here also, though certainly less decidedly than in the lower jaw, the irregularity of contour is repeated. The opening of the enamel-bell of the rudimentary tooth is directed backwards and upwards. Inside it the pulp surrounds a delicate little cap of dentine. Figs. 11 and 12 will explain these statements. Fig. 11 gives a representation of the arrangement magnified nearly fifty times. We see from the figure that the enamel-germ of the rudimentary tooth and that of the large incisor are surrounded by one and the same thickened envelope of connective tissue. Fig. 12 shows from the same section the enamel-germ of the rudimentary tooth magnified nearly two hundred times.

With reference to paragraph no. 4 the following remarks must be made :—Fig. 7 shows, magnified one hundred times, a section through the anterior rudimentary enamel-organ, which is situated close in front of the orifice of Stenson's canal. We also get a sectional view of the portion of the dental fold belonging to it; but in this section the fold is in connexion neither with the epithelium of the oral cavity nor with the transversely-directed neck of the enamel-organ. Both, however, lie together in an envelope of connective tissue, which is packed with nuclei and consists of concentric layers. In the interior of the enamel-bell distinct enamel-pulp is found: a dentine germ could not be distinguished. The most superficial nuclei of the pulp appeared clearer: this is somewhat exaggerated in the figure. They were separated from the deeper-lying dark ones by a transverse cleft, which perhaps represents a blood-vessel.

Fig. 8 shows the arrangement of the structures, magnified twenty-six times, about nine sections (15 μ) further back. The section passes through the anterior circumference of the orifices of Stenson's canals. Of the enamel-bell of the anterior rudiment only the posterior margin is still cut, while inwards from it is seen the dental fold detached from the epithelium.

Fig. 9 lies three sections further backwards (same scale). The section passes through the narrow interval between the two rudimentary enamel-organs. The dental fold is to be observed, and to the side of it a thickening of the epithelium of the oral cavity, with which the fold at other spots is connected. Lastly, fig. 10 lies only two sections behind the foregoing, and shows the second rudimentary enamel-bell. This is by far less distinctly characterized as such than is the former one. For, in the first place, it is directly attached to the outside of the epithelial fold, and is united to the epithelium of the oral cavity by means of a short thick connective cord. Secondly, the enamel-pulp is absent from its interior, and, moreover, the connective-tissue-pulp, or tooth-papilla, is not so thickly nucleated as in the case of the anterior rudiment. Yet the whole structure is enveloped in a concentric membrane of connective tissue (not visible in the figure), and, especially after examination of the model, fig. 14, it is hardly possible to doubt that the rudiment is of the nature of an enamel-organ.

CAVIA.

Of *Cavia* I was able to examine a small specimen of the cephalic length of 4·5 millim. This presented no special interest for our subject, since the tooth-rudiments were still at the very commencement of their development*.

Then come two series, one through the head of an embryo measuring 1·4 centim. in cephalic length and 2·9 centim. in all, while the other was derived from a somewhat younger specimen, which Prof. Froriep, of Tübingen, was kind enough to make over to me. The stages were so far very favourable in that they corresponded to those of the rabbit in which the rudimentary tooth-germs are most distinct. The result of the investigation was, however, an almost negative one: no trace of a rudimentary tooth and no trace of a germ for the second incisor. In the diastema there were found here and there thick cones of epithelium, which projected downwards for a

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* I am indebted for this specimen to the kindness of Dr. Keibel, of Freiburg i. B., who placed at my disposal a whole series of guinea-pig embryos. Most of these, however, were too young and consequently not available for the purposes of my investigation.

certain distance from the epithelium of the upper jaw, and were also frequently continued backwards through a few sections as detached round epithelial circles, after which, however, they always came to an end. It is very possible that these represent remnants of the dental fold, though it is true that a more definite proof cannot be advanced. We might do this if we could trace such an epithelial cone into continuity either with the dental fold of the incisors in front, or with that of the molars behind. But we can do neither. Yet one argument which supports the idea that these cones are of the nature of a dental fold is to be found in the place from which the ingrowths start, which agrees fairly well with the typical position of the dental fold in *Lepus*. It is true that in *Cavia* the relations of the epithelium of the oral cavity and of the mucous membrane of the palate are somewhat different from those in *Lepus*; but this is a question which I cannot here proceed to discuss. Moreover we might establish a proof by the process of exclusion; besides rudiments of a dental fold, the epithelial cones could only be germs of glands. It is, however, improbable that the germs of small oral pituitary glands would be already so distinct in the stage which we are considering. But this attempt at a proof is not sufficient.

CRICETUS FRUMENTARIUS, MUS MUSCULUS, *and* MUS DECUMANUS.

Few words are needed to dispose of these animals. Although we had at our disposal continuous series of at least the two last-named species, the investigation of them nevertheless produced absolutely negative results. Not a trace of rudimentary tooth-germs was found either in the neighbourhood of the incisors or in the diastema.

The discussion and valuation of my results may be divided into heads according to the questions with which we started:—

(1) Are embryonic tooth-rudiments found in the neighbourhood of the incisors in Rodents? To this we reply:—In *Lepus* we find a rudimentary tooth in the upper and lower jaw in front of the large incisor, as already discovered by Chabry and Pouchet. This remarkable observation appears to have escaped the notice of most of the subsequent authors, but I was able to confirm it and to add that evidently the same tooth-rudiment is also present in the squirrel.

Now Dr. Fleischmann has led me to inquire whether this rudimentary tooth represents the remnant of an *i.* 1—in which case the large incisor would have to be designated *i.* 2, which agrees in a remarkable manner with Cope's derivation of the Rodents, as quoted above,—or whether it must be considered as the remnant of the germ of a precursor of the large incisor. Unfortunately the material furnished by the actual results does not entirely suffice for a decision between these two alternatives.

The development of the rudimentary tooth, as I was able to follow it continuously in *Lepus*, by no means agrees in its main features with that of a milk-tooth, whether, in respect of the relation between the development of a milk-tooth and that of the permanent one, we accept the older view, which is reproduced in the text-books, or that which is held by Baume. So far as I am aware, no case is known in which the enamel-organ of a milk-tooth appears directly united with that of its successor, as MM. Chabry and Pouchet have already shown to be the case in *Lepus*, at least with regard to the rudimentary tooth of the lower jaw. In the premaxilla the French authors failed to observe the stage in question; I was able to show that here, at any rate at first, the same thing takes place in *Lepus*.

In a superficial examination of the question, the conditions pertaining to the second deciduous incisor in the premaxilla of *Lepus* tell very much against the assumption that the rudimentary tooth likewise belongs to the milk series. The deciduous incisor referred to is clearly a true precursor of the second and smaller permanent incisor. It attains a high degree of development at a time when the germ of the permanent *i.* 2, which at all events proceeds from the adjoining portion of the dental fold, is still quite small and insignificant. It is not until the last stage of fœtal life that the permanent *i.* 2 becomes more strongly developed and displaces the deciduous *i.* 2, which drops out shortly before or after birth.

Now are we to suppose that in *Lepus* the second incisor has retained a true milk-tooth as its precursor, while in the case of the first incisor the milk-tooth remains in quite a rudimentary condition, and is outstripped unusually quickly by the germ of the permanent tooth, which appears at the same time as, or even earlier than, that of *di.* 2? It is true that in explanation of this divergence we can adduce the necessity for a more speedy development of the permanent *i.* 1 (which, indeed, represents the actual large incisor), whereby to a certain extent its precursor is deprived of the necessary material for development, and is prevented from passing beyond a rudimentary condition.

Finally, we must also confess that it is more easily imaginable that the enamel-organs of a milk-tooth and its successor, which in some other way at any rate also stand in closer relation one to another, should under the special conditions in question (especially great and therefore also more rapid development of the permanent tooth) fuse together, than that two tooth-germs situated one behind the other, which have otherwise nothing whatever to do with one another, should enter into intimate mutual relations of this kind. Another telling point is that the rudimentary tooth and the incisor lie together not only in an alveolus, but also, as may be seen with especial distinctness in the case of the squirrel, in one tooth-sac of connective tissue. I do not wish to attach too great weight to the relative position of the tooth-germs. It is true that the rudimentary tooth lies in front of the incisor, but the deciduous *i.* 2, which we must yet certainly regard as a milk-tooth, also lies, at least according to the representation of MM. Chabry and Pouchet, in front of the germ of the second permanent tooth. This is connected with the peculiar conditions of space in the jaws of Rodents. It appears to me to be of more importance that in the squirrel, in which the conditions in question seem to be to a certain extent less abnormal than in the rabbit, the enamel-germs of the rudimentary and permanent tooth are connected together by their "necks" (and this both in the upper as well as in the lower jaw) precisely as this is usually described for the milk-tooth and its successor. Altogether I am personally more inclined to the view that *the rudimentary tooth is to be considered as the rudiment of a precursor of the large incisor in process of active degeneration*, though I am ready to admit that this can by no means be regarded as finally established. It may further be specially pointed out that in *Sciurus*, which in many respects has proved even more conservative than *Lepus*, no distinct trace could be discovered of *i.* 2, which *Lepus* has preserved in the shape of the milk-tooth and its successor. It will be shown later on that the anterior of the two enamel-organs, which I have proved to exist near the orifices of Stenson's canals, can only with difficulty be regarded as *i.* 2. Further investigations will have to determine whether the rudimentary teeth, as they appear in the stage of *Sciurus* examined by me, have exactly arrived at the height of their development, whether they develop still further, or, lastly, whether they are not perhaps already in process of degeneration.

(2) In the Rodents examined are germs of teeth found in the diastema? To this our discoveries enable us to reply:— In *Lepus* a well-developed dental fold is found throughout the

entire length of the diastema, but only in the upper jaw, which was expressly denied by Pouchet and Chabry.

Upon this dental fold, however, enamel-organs are never developed in *Lepus*. After having lasted for a somewhat lengthy period, it disappears without leaving a trace behind.

In the upper jaw of *Sciurus* in the stage we examined a dental fold was present, which was interrupted for a certain distance behind the canals of Stenson, but was otherwise greatly extended and continuous. According to Chabry and Pouchet it is just in front of Stenson's canals that the fold is wanting. Moreover it is asserted by the French authors, though their statements upon this point are certainly somewhat confused, that in the lower jaw there is a complete dental fold throughout the entire diastema. In our stage, which was but a little older, it was possible to distinguish mere traces of a prolongation of the dental fold close behind the rudiment of the incisor in the lower jaw, so that the statement of MM. Chabry and Pouchet does not appear to me to be a very credible one. On the other hand, we may with confidence assume that in younger stages of the squirrel the dental fold of the upper jaw will be found perfectly continuous in the diastema.

In addition to this we find in *Sciurus* near the canals of Stenson two enamel-organs lying one close behind the other, of which the anterior is quite undeniably characterized as such, while the posterior bears somewhat less distinct, but nevertheless sufficiently definite, indications of its character. It is remarkable that Chabry and Pouchet have figured one of these rudiments, but, as we have seen, have interpreted it quite incorrectly.

How are these structures to be regarded? The anterior enamel-organ can scarcely be regarded as a remnant of the *i.* 2 which is present in *Lepus*; for in this animal the cord connecting *i.* 2 with the epithelium of the oral cavity is attached far in front of the orifices of Stenson's canals; the interval which is visible in fig. 14 (of the squirrel) between this rudiment and that of *i.* 1 appears much too great for it to be possible to assume that we are here dealing with two tooth-rudiments following directly one after the other. It is true that this question too will not be finally decided until we have examined younger stages, since the possibility of a secondary divergence of the two rudiments is also not excluded, although it is not probable that this has taken place. Moreover it will be determined only by further investigations whether a deposition of dentine still takes place in these rudiments or not, and how they disappear. Taking the conditions as we find them in the stage under consideration, we might regard these two enamel-organs as remnants of rudiments of a posterior incisor and a canine tooth which have been strangely preserved; their interpretation as remnants of premolars is opposed by their position beside the orifices of Stenson's canals.

The reader may here once more be reminded that in *Cavia* only very doubtful remnants of the dental fold were distinguishable in the diastema, while in *Cricetus* and *Mus* no trace of a rudimentary embryonic dental germ was visible.

In conclusion, it may be also pointed out that our results correspond to Fleischmann's view, according to which the degeneration of the tooth-rudiments has advanced further in the lower than in the upper jaw. Apart from the doubtful statements of MM. Chabry and Pouchet with regard to the squirrel, no dental fold was found in the diastema in the lower jaw; in the upper jaw, on the other hand, a structure of this kind was distinguishable in a condition of greater or less completeness in *Lepus*, *Cavia*, and *Sciurus*, while in the case of the last-mentioned form it is even provided with enamel-organs. It also agrees very well with the general views of Schlosser and Fleischmann, that the Lagomorpha represent an especially old and conservative Rodent type, and that after these the Sciuromorpha come next in order; that in representatives of these groups it was possible to demonstrate the most distinct and most widely extended embryonic remains of tooth-rudiments which have disappeared; while in the more highly modified Myomorpha, in so far as these were investigated, the embryonic reduction was also more complete. Lastly, stress may likewise be laid upon the fact that the discovery of a dental fold in the diastema in the case of *Lepus* and *Sciurus* is in conformity with the similar discoveries of other authors in the case of different Mammals with incomplete dentitions. Thus the presence of a dental fold in the diastema in the premaxilla of Ruminantia was not long since finally determined by Mayo *. For the Edentata the same was proved by Chabry and Pouchet, and it is well known that in the case of the whalebone whales Geoffroy St.-Hilaire has demonstrated the existence not only of the dental fold, but even of entire embryonic teeth, which merely fail to cut the gum and are absorbed within the jaw.

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* Mayo, "The Superior Incisors and Canine Teeth of Sheep" (two plates), 'Bulletin of the Museum of Comparative Zoology at Harvard College,' vol. viii. (Cambridge, 1886-1888).

At the end of my paper I will add a few words of thanks.

In the first place, I am most deeply indebted to Prof. G. Born, Prosector to the Royal Anatomical School of Breslau and Director of the Embryological Section. It was he who first induced me to undertake these exceedingly interesting and instructive studies, he initiated me into the always difficult *technique* which work of this kind demands, and he assisted me by word and deed wherever he could, shunning no trouble and no expense. In return for his extraordinary amiability and self-sacrificing care I trust I may be permitted once more to express here my heartiest thanks to Prof. Born.

I am likewise under very special obligations to Prof. Hasse, Director of the Royal Anatomical School of Breslau, for the permission which he most readily accorded to me to work in the Embryological Laboratory of the School.

Lastly, my best thanks are due to Dr. A. Fleischmann, of Erlangen, who drew my attention to a series of highly remarkable facts, introduced me to the palæontological literature of the subject, and furnished me with very valuable statements and observations for my memoir.

LIII.—*On the Habits of a Species of* Trigona.

By J. H. Hart, F.L.S., Royal Botanic Gardens, Trinidad.

Among the several species of *Trigona*, or "wild bees," which are common in Trinidad none is more interesting in its habits than a peculiar small dark species which is often found in the proximity of dwelling-houses, under slates, or in crevices of the woodwork of out-buildings.

The specific name of the insect has not been ascertained, but it has been found that it belongs to the genus *Trigona*. It was first observed in 1887 in the walls of a dwelling-house, owing to its building a peculiar entrance-tube. This tube was about $\frac{3}{4}$ of an inch in diameter, about 4 inches long, with the entrance at the bottom, through a small hole in the centre of the wax disk which closes it.

When the office of the Royal Botanic Gardens was under repair quite recently the same species was discovered making its home between two walls.

An attempt was made to house them, and a small box prepared, with a small cut for entrance allowed, in a similar manner to that usually seen in the common bee-hive, viz. at the base. The bees took to the box and commenced work;

but after the first day they closed the lower entrance very completely with a sticky kind of wax, and adopted a small crack in the upper portion of their box as the entrance. To the inside of this crack they attached a tube similar to the one first observed, but completely adapted to the new position, by first building it along the crack and afterwards in a pendulous manner downwards.

Wishing to have the insects more completely under observation, I built a small glass-sided box with sliding covers, made an entrance for them in the top gable, and transferred them thereto. They again took very kindly to their new quarters and commenced work by rapidly sealing up every crevice, making their home practically air-tight. To the entrance they again attached the entrance-tube, which in this case was brought from the entrance inwards, but built in the same manner as the previous ones. It was, however, supported by wax stays, by which it was held at about $\frac{3}{4}$ inch distant from the inside wall.

During the removal from their former home opportunity was taken to examine the construction of their peculiar entrance-tube, and it was found on making a section that it was constricted in several places by disks, leaving only sufficient space in the centre for the passing of one bee at a time; and, if beaten back from the first, they have still the chance of holding the inner ones in succession. These constrictions and the sealing-up are evidently adopted by the insects as a means of defence against their enemies. A further defensive measure may be seen if the nest is examined after nightfall, when it will be found that the orifice which admits of ingress and egress during the day is sealed completely over, all but imperceptible orifices being left in the closing sheet of wax, we suppose for the admission of air. This safeguard is regularly removed in the early morning near daybreak, and again closed each night after nightfall. The honey-cells of this bee are distinct from the breeding-cells, are ovate in shape, over $\frac{3}{4}$ inch in length, and somewhat pointed at the closed apex; and the food- or pollen-cells are of the same form and size, but situated at a different part of the hive. The honey-cells are separated from the rest of the nest; they are affixed closely together, and are somewhat irregular in size, but firmly fixed to the side-wall of the hive in one layer only, cones pointing upwards. The pollen-cells are spread over the floor-space, reminding one of sacks of grain in a granary. The breeding-cells are not more than $\frac{3}{8}$ inch in length, regularly oval and in single tiers, held in position separate from each other by small wax stays, which leaves each cell separate and distinct from its neighbour, though generally on the same or nearly the same horizontal plane.

In our nest there are several layers one above another, the main support being thin walls of wax built up the sides and throughout the mass at intervals in a perpendicular manner, and reaching to the top of the hive.

The queen has a very large body, very much larger in comparison with the workers than that of the queen of the common hive-bee, and very similar to some of the termites. A small dipterous insect was observed in the nest when it was first taken, but this disappeared after it was fully sealed. This may prove to be the natural enemy of this insect.

Our bee has no sting, which renders it particularly easy to handle and observe, and the want of which doubtlessly occasions it to use such careful means of defence to secure its home from the attacks of its enemies.

The honey is perfectly sweet and wholesome, very clear, and of a nice flavour, but when squeezed out soon becomes sour.

Another species of *Trigona* is found in hollow or decayed trees in our gardens, in large nests 2 to 3 feet in diameter, formed of black, gummy, waxy, or resinous matter. This species is very pugnacious, and attacks persons coming near it, with a buzz and hum similar to that of the common honey-bee; but it is powerless to harm, as it has no sting. It, however, fixes itself in the hair of the head or beard, and produces a peculiar tickling feeling, which quickly induces a sensation of fear in those who know the result of the attack of an angry common hive-bee; and even when its character is known the attack (almost unconsciously) causes the intruder to retreat.

LIV.—*Description of Two new "Pocket-Mice" of the Genus* Heteromys. By OLDFIELD THOMAS.

WHILE attempting to determine a specimen belonging to the genus *Heteromys* obtained by Dr. Audley Buller in Jalisco, Mexico, I have found it necessary to make an examination of all the species of the genus, and I find that they are readily divisible into groups by the characters of the soles, whether naked or hairy, with five pads or six. These characters do not seem to have been known to Mr. Alston when, in his great work on the Mammals of Central America, he lumped under one heading four species described by Gray and one by Peters; for two of the five, namely *H. irroratus* and *albolimbatus*, are hairy-soled, with five pads, and the other three, *H. melanoleucus*, *longicaudatus*, and *adspersus*, are naked-soled and have six pads. To the first group there also belong *H. Alleni*, the South-Texan species, and *H. Bulleri*, the Mexican one now described; while to the second, besides those mentioned, there should be added the Trinidad species, *H. anomalus*, Thomps., and Gray's *H. Desmarestianus*. Finally, the second new species now described, *H. Salvini*, forms a third, annectant, group, with the hairy sole of the first and the six pads of the second.

Heteromys Bulleri, sp. n.

Intermediate in size between *H. Alleni* and *H. irroratus*. General colour above the usual smoky grey, grizzled and lightened with yellowish; sides with an indistinct yellowish band along the junction of the back and belly colours; lower surface from mouth to anus pure white; ears dark, apparently not white-edged; hands and feet white; arms to elbow also white, but on the hind limb the dark colour of the rump passes down to the heel and all round the ankle, but the inner side of the upper leg is white.

Claws, especially the anterior ones, very long. Soles of hind feet hairy for their posterior half, the hairs pale brownish; sole-pads five in number; the large posterior pad circular in outline. Tail rather longer than the head and body, well-haired throughout, clearly bicolor, brown all along its upper surface, white on the sides and below.

Mammæ 1—2 = 6.

Skull strong and stoutly built, differing mainly from that of *H. Alleni* in its much greater size, and from that of *H. irroratus* by its differently shaped interparietal, which, more like that of *H. Alleni*, is comparatively rounded, with its longitudinal 62·5 per cent. of its transverse diameter, and has its anterior edge very convex forwards.

Teeth much worn in the only specimen, but in their shape and proportions they do not seem to differ from those of *H. Alleni*. Equally worn teeth of *H. irroratus* are not available for comparison.

Dimensions of the type (an adult female in alcohol):—

Head and body 114 millim.; tail 120; hind foot 28·5 *

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* Without claw.

ear, above head 10·5, from notch 15; heel to front of last foot-pad 12·5.

Skull: basal length 29·5; greatest length 34·5; greatest breadth 16·8; nasals, length 13·5; interorbital breadth 8·5; interparietal, length 4·0, breadth 6·4; diastema 9·5; palate, length 21; length of upper tooth-series 5·3.

Hab. La Laguna, Sierra de Juanacatlan, Jalisco, Mexico, 7000 feet. Coll. Dr. A. C. Buller, December 1892.

A male specimen of *H. Alleni* from Brownsville, Texas, the typical locality, has a caudal length of 110 and a basal length of 26 millim., while a full-grown skull has a greatest length of 30·3 millim., from which it will be seen that that species is considerably smaller than *H. Bulleri*.

Heteromys Salvini, sp. n.

Heteromys longicaudatus, Alst. Biol. Cent.-Am., Mamm. p. 167, pl. xvii. fig. 2 (1880) (nec Gray).

Size about equal to that of *H. Bulleri*, but the feet are decidedly shorter, being as short as in *H. Alleni*. Fur spiny as usual. General colour blackish, rather darker than in most of the other species, grizzled with yellowish on the back. Lower surface pure white, as usual. Outer sides of forearm with a narrow slaty-grey edging, more conspicuous than in *H. Alleni* and *Bulleri*, less than in *H. longicaudatus*. Hind foot very short, as short as in *H. Alleni*; posterior half of sole covered with short brownish hairs; pads six, as in the larger naked-soled species, the two posterior pads very close together in the median line of the foot. Tail thinly haired, bicolor, but not so sharply and decidedly as usual, brown above, whitish below.

Skull in size and shape very like that of *H. Bulleri*, but the interparietal is much more extended transversely, while only of about the same antero-posterior diameter; its longitudinal percentage is therefore only 44 of its transverse.

Molars proportionally small and slender.

Measurements of the type (an adult male in skin):—

Head and body (c.) 115 millim.; tail (imperfect at tip) 95+?; hind foot 26·5; heel to front of last foot-pad 11.

Skull: basal length 28; greatest length 33·6; greatest breadth 15·2; nasals, length 13·1; interorbital breadth 7·6; interparietal, length 4·5, breadth 10·2; diastema 8·9; palate, length 19·2; length of upper tooth-series 4·4.

Hab. Dueñas, Guatemala. Coll. O. Salvin, July 31, 1873.

The type specimen of *H. Salvini* is the very one referred to and figured by Mr. Alston in the work above quoted.

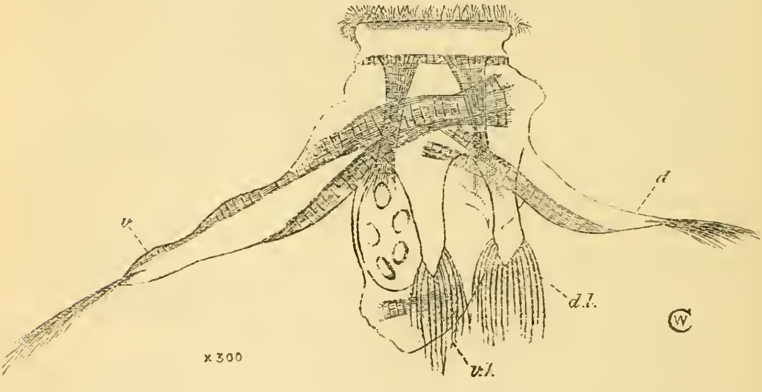
It is with great pleasure that I connect with this interesting annectant species the name of Mr. Osbert Salvin, its discoverer in 1873, and one of the editors of the great work in which it is so beautifully figured.

A *Heteromys* from Costa Rica, in the Museum collection, also appears to belong to *H. Salvini*; its hind feet agree precisely in their structure with those of the type, but are even shorter, measuring only 25 millim.

LV.—*A new* Pedalion. By W. T. Calman,

University College, Dundee.

The remarkable rotifer *Pedalion mirum*, discovered by Dr. Hudson in 1871, has been the source of much interest and speculation to zoologists on account of its aberrant form and supposed arthropod affinities. Though it has since been found in several localities, both in this country and on the continent *, it has always been a great rarity, and no allied forms were known until Dr. K. M. Levander, of Helsingfors, announced in the 'Zoologischer Anzeiger' for October last †



Pedalion fennicum, Levander.—*d*. dorsal appendage; *v*, ventral appendage; *d.l.*, dorso-lateral appendage; *v.l.*, ventro-lateral appendage.

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* See Imhof, "Notiz ü. d. Vorkommen von *Pedalion mirum*, Huds.," Zool. Anz. 13 Jahrg. pp. 609–611 (1890).

† K. M. Levander. "Eine neue *Pedalion*-Art," Zool. Anz. xv. pp. 402–404 (1892); "Zusatz z. meiner Mitth. über *P. fennicum*," ibid. xvi. pp. 26, 27 (1893).

the discovery of a second species of the genus in Finland. By the kindness of Dr. Levander the Dundee Museum has lately received some excellently preserved specimens of the new *Pedalion fennicum*, from which the annexed figure is taken. Dr. Levander will no doubt in due course figure the species and publish his completed researches on its structure; but meanwhile this figure and the following notes may be temporarily of interest.

Although bearing a great resemblance to *P. mirum*, the new species differs from it in many details, of which the following are the most conspicuous:—

(1) The two stylate processes at the posterior end of the body, which form a conspicuous feature of *P. mirum*, are here wanting.

(2) The dorso- and ventro-lateral appendages are nearly equal in size. In *P. mirum* the dorsal is the shorter.

(3) The unpaired ventral appendage hardly reaches beyond the posterior end of the body. In *P. mirum* it is very much longer.

(4) The bristles of the ventral, and less markedly those of the other appendages, for the most part arise in pairs from a common base in a manner similar to that shown in Dr. Schmarda's figure of *Hexarthra polyptera*.

The length is about ·23 millim. Only females were found, many bearing one or two reddish eggs attached to the hinder end of the body. In a few cases a larger number (about ten) of small eggs was seen, which Dr. Levander conjectures with great probability to have been male eggs.

With regard to the habitat, Dr. Levander says:—"The animal occurred in numbers in a pool of water about two yards square by a foot deep, on a bare granite cliff on the little islet of Löfö, about 12 km. south-west of Helsingfors, in company with *Daphnia pulex*, *Chydorus sphæricus*, and *Cyclops*, sp. The little pool was about 10 yards from the sea-shore and not a yard above the sea-level; no vegetation; grey detritus on the bottom; the water moderately clear, sweet."

BIBLIOGRAPHICAL NOTICE.

British New Guinea. By J. P. Thomson.
G. Philip and Son: London, 1892.

The illustrations and general style of this handsome volume are highly creditable to the publishers; while as regards the matter, we can at least say that we are presented with a useful and readable summary of the state of our knowledge of Papua, fairly up to date. It is of course to be regretted that reports of Sir William Macgregor's explorations of the Bamo—an important affluent of the Fly River—as well as of the country to the eastward, should not have reached Mr. Thomson in time for insertion; but that is not the fault of the compiler: for, to prevent misunderstanding, we may say at once that the book is a mere compilation by one who, we believe, has never visited New Guinea, but, from his abode in Brisbane has sung the achievements of his "fellow-officer," the Administrator of British New Guinea. Far be it from us to undervalue the work done by Sir William Macgregor; but when we find that the surveys made by his predecessors—distinguished naval officers like Capt. Moresby, Commanders Pullen and Field, and others—are treated without due sense of proportion, while every thing is attributed to "the Administrator," a certain feeling of antagonism is aroused, and this is increased by the inflated tone adopted by the author. We will quote the heading to the first chapter, for it seems to furnish a keynote to the book:—"It appears to me to be a noble employment to rescue from oblivion those who deserve to be eternally remembered, and, by extending the reputation of others, to advance at the same time our own.—Plinius minor." If Sir William is pleased with the manner in which *his* reputation has been extended he must have a strong stomach.

An "Historical Sketch"—far too brief—brings us to the year 1888, when British sovereignty was proclaimed at Port Moresby; after which the Administrator visited the Louisiade Archipelago, the D'Entrecasteaux group, the southern coast of Papua as far as the Dutch limit, and the northern shore up to the German protectorate. These tours of inspection are not badly described, and the account of the attainment of the highest peak in the Owen Stanley Range (12,452 feet) affords some important details respecting the configuration of the mountain mass; but we must add our protest to those of others against the substitution of the name "Mount Victoria" for that bestowed upon the peak many years ago. From a scientific point of view the most valuable portion of the work is the Appendix, which contains some succinct general notes on the Flora of British New Guinea, by Baron von Müller; a full report (occupying 50 pp.) on the Insects, by Mr. Henry Tryon; an interesting chapter on the Reptiles, by Mr. C. W. De Vis; several important vocabularies, &c. To the above-named gentlemen and some other "collaborators" Mr. Thomson expresses his gratitude, and without doubt it is well deserved.

MISCELLANEOUS.

Classification of the Pelecypoda.—Emendatory Note.
By B. B. Woodward, F.G.S. &c.

By an oversight, when rearranging Fischer's families of the Pelecypoda to suit Pelseneer's classification, the Tancrediidæ, which by Fischer are placed between the Unicardiidæ and the Donacidæ, were grouped with the former instead of with the latter. In the table given, therefore, in the February number of the 'Annals,' pp. 158, 159, the Tancrediidæ should stand as Fam. 42 instead of 49, and the Fams. there numbered 42 to 48 should be 43 to 49.

A Contribution to the Developmental Cycle of the Compound Ascidians. By Johan Hjort, of Christiania.

I.

(1) Like Metschnikoff [*] and Della Valle [†] I have always found that the earliest rudiment of the bud of *Botryllus* is in the shape of a two-layered vesicle, of which the inner layer proceeds from the parietal layer of the peribranchial cavity, while the outer one is derived from the ectoderm of the larva. I have never been able to confirm the repeated assertions of Giard [‡] and Herdman [§] that in the Botryllidæ a "stolonial" gemmation occurs, in that the buds are produced from the stolons of the mantle. Owing to the very numerous transitional stages it is even possible to explain the usually widely separated buds of colonies of *Botryllus* as having arisen in consequence of a "pallial" gemmation. While, however, Della Valle regards the inner vesicle of the bud-rudiments which is formed in the course of this pallial gemmation as endodermal, I myself feel bound, in accordance with the investigations of Kowalevsky [||] and Van Beneden and Julin [¶] and studies recently made by Willey [**], to consider this vesicle as ectodermal, since, according

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[*] "Entwicklungsgeschichtliche Beiträge," Mélanges Biologiques tirés du Bull. de l'Acad. de St. Pétersbourg, t. vi.

[†] "Sur le bourgeonnement des Ascidies composées," Archives Italiennes de Biologie, 1882.

[‡] "Recherches sur les Ascidies composées," Archives de Zoologie expérimentale, 1872; also 'Comptes Rendus,' 1891.

[§] Report of the 'Challenger' Expedition, vol. xiv.

[||] "Weitere Studien über die Entwicklung der einfachen Ascidien," Archiv f. mikr. Anat. 7 Bd., 1871.

[¶] "Recherches sur la morphologie des Tuniciers," Archives de Biologie, t. vi., 1886.

[**] "On the Development of the Hypophysis in the Ascidians," Zoologischer Anzeiger, xv. Jahrg. no. 400, pp. 332–334.

to the investigations referred to, the peribranchial vesicle of the larva proceeds from its ectoderm. The entire bud-rudiment of the Botryllidæ consequently consists, as in the case of the Bryozoa, of two epithelial lamellæ of ectodermal origin, with mesodermal cells scattered in between. It follows from this that the gemmation of the Botryllidæ differs in this respect from that of the other Ascidians, such as *Perophora*, *Clavelina*, *Amaroucium*, *Didemnium*, and *Distaplia*, since in all these cases, either directly or indirectly (through the epicardium and the stolonial septum), the inner vesicle is formed from the endoderm.

(2) From the inner vesicle are developed the intestinal tract, the peribranchial vesicle, and the nervous system.

The process by which the peribranchial vesicle is formed is ushered in by the upheaval of the ventral wall of the inner vesicle, commencing from in front, into two folds which project into the interior. By this means from the single inner vesicle there is formed a median one, which communicates posteriorly by an opening on each side with two lateral ones, the peribranchial vesicles. Now Della Valle asserts that three separate vesicles arise and that the two lateral ones form by fusion the single peribranchial cavity. I have been unable to confirm the occurrence of this secondary fusion; on the contrary, the peribranchial cavity is formed from the beginning as a saddle-shaped double vesicle, which becomes constricted off dorsally from the median vesicle.

The earliest rudiment of the nervous system takes the shape of a nearly hemispherical evagination, situated at about the centre of the dorsal wall of the median vesicle. This evagination soon grows out into a tube, which is directed anteriorly and ends blindly in front. The closed anterior end of the cæcum fuses afresh with the median vesicle; an aperture is formed here, and we now find upon the dorsal side a tube with both ends opening into the median vesicle. The anterior opening lies not far from the oral aperture, which now arises as a fusion between the ectoderm and the enteron; the posterior opening of the tube communicates with the dorsal portion, which connects the two lateral halves of the saddle-shaped peribranchial vesicle. While the latter, as has been described, becomes constricted off from the intestine, this posterior opening also closes up, and we simply find a dorsal tube communicating in front with the intestine.

(3) At this stage we already observe a thickening of the ventral side of the tube, which increases considerably during the subsequent development. Moreover it becomes more and more constricted off from the dorsal section of the tube, while delicate fibres are differentiated in its interior.

This thickening develops into the permanent ganglion, while the tube, which gradually becomes longer and thinner, persists as the hypophysis.

I would here point out that Kowalevsky *, in the case of *Didem-*

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* "Ueber die Knospung der Ascidien," Archiv f. mikr. Anatomie.

nium styliferum, *Perophora* [*], and *Amaroucium*, likewise derives the nervous system from the inner vesicle, although in a somewhat different fashion. Consequently both in the forms alluded to and in *Botryllus* the intestinal tract, the peribranchial cavity, and the nervous system proceed from the inner vesicle of the two-layered bud-rudiment.

While, however, in the first-mentioned forms this inner vesicle is endodermal, in *Botryllus* it is, as has been shown, of an ectodermal nature.

As is evident from what has been stated above, these results of mine are diametrically opposed to the conceptions of Seeliger [†] and Salensky. In the case of the buds of *Clavelina* and *Pyrosoma* [‡] the nervous system is derived by Seeliger from immigrant mesoderm cells, while in the latter form it is stated by Salensky [§] to arise as a thickening of the "outer vesicle." With the last-mentioned author, however, I am so far in agreement in that I also have found a common origin for the hypophysis and the ganglion.

II.

The mode of formation of the ganglion in the buds of *Botryllus* led me also to study the development of the same organ in the larvæ of compound Ascidians. It will be seen from what follows that owing to these investigations I have discovered several parallels between the development of buds and larvæ.

In the cerebral vesicle of the larva of *Distaplia magnilarva* there appears at an early stage a difference between the left and right sides. Nearly in the middle of the right side of the cerebral vesicle there arises an evagination, which soon exhibits the most manifold differentiations, and from which in later development proceeds the larval brain, which has been so exhaustively described by Van Beneden and Julin [‖].

The left wall, however, in the meantime maintains its indifferent cellular character: at first consisting of a single layer, it gradually increases in thickness.

In front of the described evagination of the right wall of the cerebral vesicle the latter becomes tubular and joined to the intestine. This anterior portion possesses cells of the same constitution as that of those of the left wall.

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[*] Kowalevsky, "Sur le bourgeonnement du *Perophora Listeri*" (transl. by Giard), Rev. d. Sc. nat., Sept. 1874.

[†] "Eibildung und Knospung von *Clavelina lepadiformis*," Sitzgsber. d. kais.-kgl. Akad. d. wiss. Wien, 1882.

[‡] "Zur Entwicklungsgeschichte der Pyrosomen," Jenaische Zeitschrift, 23 Bd.

[§] "Beiträge zur Embryonalentwicklung der Pyrosomen," Zoologische Jahrbücher, 1891.

[‖] "Le système nerveux central des Ascidies adultes et ses rapports avec celui des larves urodèles," Archives de Biologie, t. v., 1884.

During the development which succeeds this stage the following important changes set in :—

(1) The anterior portion of the cerebral vesicle, which was joined to the intestine, acquires an opening into the latter, and thus forms a communication between intestine and cerebral vesicle which persists throughout the whole of the larval period.

(2) The multilaminate left wall of the cerebral vesicle produces nearly at its middle a thickening, which gradually becomes constricted off, and goes to form the permanent ganglion.

The left wall itself, which hitherto formed an undivided mass in conjunction with the permanent ganglion, after the latter has become constricted off assumes an epithelial character. In front it is directly continuous with the anterior portion of the cerebral vesicle. This portion also becomes epithelial, elongates, and represents the well-known ciliated pit.

(3) Now while the larval brain (formed by the evagination of the right wall of the cerebral vesicle) becomes constricted off and disappears, the epithelium-like left wall of the original cerebral vesicle bends round into a tube, which represents an immediate prolongation of the ciliated pit just described, and in which we recognize the hypophysis.

(1) In the development of the larva, as in that of the bud, we consequently find that the hypophysis and the persisting ganglion have a common origin.

(2) The common rudiment is tubular in both modes of development, and in both cases the ganglion is formed as a thickening of the tube.

(3) The larval cerebral cavity opens, as described by Kowalevsky* and disputed by Van Beneden and Julin †, through the hypophysis into the intestine.

(4) In the adult animals, produced from the larva, there persists from the lumen of the larval cerebral vesicle only the lumen of the hypophysis.

The above investigations were carried out in the Zoological Institute in Munich and in the Zoological Station at Naples. It is a pleasing duty to express to my revered teacher, Prof. Hertwig, and to Dr. Dohrn my best thanks for all the kindness shown to me. —*Zoologischer Anzeiger*, xv. Jahrg. no. 400 (Sept. 12, 1892), pp. 328–332.

Munich, June 29, 1892.

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* "Weitere Studien über die Entwicklung der einfachen Ascidien," Archiv f. mikr. Anat. 7 Bd., 1871.

† *Op. cit.*

The Development of the Intestinal Gregarines of Marine Worms.
By M. Louis Léger.

The Gregarines with a single segment, which are very frequently met with living freely in the digestive tract of a large number of Annelids, have hitherto been considered to be Monocystidea.

The study of the development of *Doliocystis nereidis*, parasitic in the intestine of *Nereis cultrifera*, and of *Doliocystis polydoræ* from the intestine of *Polydora Agassizi*, shows that these Gregarines are in reality Dicystidea, exhibiting in their earliest youth the intra-cellular stage, followed by a stage of budding which gives rise to the Gregarine proper. During the budding stage the Gregarine always exhibits two segments—the intra-cellular segment, or *epimerite*, and the extra-cellular segment, in which the nucleus is contained. It is therefore at this moment only that the Gregarine appears as a true Dicystid; but this condition does not last long. At a very early period the young individuals drop their epimerite and become free in the intestine, when they exhibit all the characters of true *Monocystis*, with which they have hitherto been confounded.

In order to study the development of *Doliocystis nereidis* it is necessary to examine with much care the elements of the epithelial lining of the digestive tract of the *Nereis*, especially in its anterior third. Individuals will then be met with which are extremely young and still in the Coccidiid stage, that is to say, in the state of a simple spherical nucleated mass, situated between the nucleus of the cell and the surface. In the subsequent stages the primitive Coccidiid has budded forth a segment, which makes its way into the lumen of the digestive tract, and which is destined to form the Gregarine proper. Finally, in a still more advanced stage the Gregarine is definitively constituted; the extra-cellular bud has considerably increased in size, and a layer of transverse muscular fibrils has already become differentiated, while the intra-cellular portion, on the contrary, is reduced to the condition of a simple little knob (epimerite). Conditions such as this are met with pretty frequently in the preparation, and we may even observe free individuals of which the epimerites are still capped with the shrivelled epithelial cells ; this is the *Cephalin* stage, which is soon concluded by the falling off of the epimerite, to give place to the stage of the *Sporadin*. The Gregarine is henceforth free in the intestine, in the form of an ovoid or elongated *Monocystis*, more or less drawn out into a point at one of the poles.

The development of *Doliocystis polydoræ*, a new species which I have met with in the Bay of Marseilles, takes place in precisely the same manner ; only the epimerite is developed to a greater extent than in the preceding species ; moreover it persists for a long time, the result of which is that Cephalins of this species are commonly encountered. This epimerite is in the form of an inverted frustum of a cone, and it is directly continuous with the anterior extremity of the second segment, which is elongated in the shape of a neck. At the moment of the falling-off of the epimerite, which is easily observed under the microscope, a broad wound is produced by which granulations of the endocyte make their escape; but this promptly cicatrizes, and the Gregarine soon no longer exhibits any traces of its first segment—it has passed into the *Monocystis* stage.

The development of these two species is thus identical with that of the genus *Schneideria*, which we may justly consider as the most perfect type of the Dicystid Gregarines. The only difference consists in the fact that the epimerite always remains very simple and rudimentary in *Doliocystis*, while in *Schneideria* it attains a certain degree of complication. Moreover it is interesting to note that, in a general way, the epimerites of the marine Gregarines never exhibit so high a degree of differentiation as do those of the majority of the terrestrial forms; they all belong, at least in the species which I have studied hitherto, to the group of the *regular simple epimerites.*

The free stage is succeeded in *Doliocystis* by encystment and sporulation, which take place normally as in the other Polycystidea. The cysts of *Doliocystis nereidis*, which I have succeeded in cultivating in spite of their extremely small size, give rise when mature, by means of simple rupture, to oval corpusculated spores, measuring 7 μ in their long axis by 5 μ in their short axis. They exhibit a remarkable thickening of the wall at one of the poles, which is a very important character in my opinion, since it is also common to the spores of the genus *Schneideria.*

Thus we see that the Gregarines with a single segment from the digestive tract of marine worms exhibit the same mode of development and the same form of spores as do the typical Dicystidea; it is therefore in this group that they must in future be placed, and it is necessary to distinguish them henceforth from *Monocystis* proper, the development of which is entirely different, and which, moreover, inhabits almost exclusively the general body-cavity.

While retaining the generic name of *Monocystis* for these latter forms, I propose to unite the former, that is to say the *pseudo-Monocystis* of the digestive tract of worms, under the common generic name of *Doliocystis*; as regards their specific name, this will be very well indicated by the name of the host which harbours them. We shall have *Doliocystis nereidis* for the Gregarine of *Nereis*, *Doliocystis polydoræ* for that of *Polydora*, &c.

Thus the confusion resulting from the union under the same name of genera essentially distinct will cease, and the group Dicystidea will therefore comprise two important genera:—

(1) The genus *Schneideria*, peculiar to the digestive tract of terrestrial Arthropods;

(2) The genus *Doliocystis*, peculiar to the digestive tract of marine worms.—*Comptes Rendus*, t. cxvi. no. 5 (January 30, 1893), pp. 204–206.

THE ANNALS

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[SIXTH SERIES.]

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LVI.—*On some new Bornean Mammalia.*
By Oldfield Thomas.

The British Museum has recently received from Mr. Alfred Everett a further considerable consignment of small mammals from Sarawak and North Borneo, and in working them out in conjunction with others received of late years from the same region the following species prove to need description:—

Cynopterus maculatus, sp. n.

Size very small, the smallest of the genus. Muzzle with its central groove almost obsolete. Ears small, oval, laid forward they barely reach to the posterior corner of the eye; their tip rounded; their outer base with a distinct rounded lobe, as in *C. brachysoma*; their colour black, but with a distinct white or yellowish spot on the centre of their inner margin. Thumb involved in membrane for half its length. Calcar and interfemoral membrane fairly well developed. Tail wholly absent. Palate with about twelve simple ridges, the anterior ones much curved, the posterior two or three directly transverse.

Fur above thinly covering the membranes near the body and the base of the forearm, but not extending on the tibiæ, although the backs of the feet are fairly well clothed.

Colour of fur above sooty grey, paler, with a tinge of rufous, on the back, darker, almost black, on the head. Below dull uniform grey, paler than the back.

Ground-colour of ears and membranes black, but on all the finger-joints and on the membranes between them there are numerous prominent yellow spots, forming a most obvious and peculiar characteristic. As already noted, there is also one of these spots on the anterior margin of each ear.

Skull with the usual short muzzle of *Cynopterus* and showing no tendency towards that of *Xantharpyia*.

Teeth different in number to those of any other known species, viz.:—I. $\frac{2}{1}$, C. $\frac{1}{1}$, P. $\frac{3}{3}$, M. $\frac{2}{2} \times 2 = 30$.

Inner upper incisors nearly twice the length of the outer ones; canines short, not much exceeding in length the middle premolar. Anterior premolar and last molar both very minute, about equal in section to one of the inner upper incisors. Lower anterior premolar and posterior molar also very small, equal to each other, and about two or three times the size of the corresponding upper teeth.

Dimensions of the type (an adult male in spirit):—

Forearm 41 millim.

Head and body 65; ear from notch 10; thumb (including claw) 16·6; index finger (including claw) 31·5; metacarpal of third finger 30; lower leg 14·5; calcar 4·4; depth of interfemoral in centre 4.

Skull: basal length 20·6; greatest length 23; greatest breadth 15·7; interorbital breadth 5·2; palate length 11·9.

Hab. Sarawak. Coll. A. Everett, June 1892.

This most remarkable little species, of which six specimens were obtained, is distinguished from all others by its extra posterior molars, two instead of four lower incisors, and by the characteristic spotting of the wing-membranes and joints. In other respects, in colour, size, and the absence of a tail, it appears to agree with *C. melanocephalus*, Temm., which Dobson erroneously placed with the tailed species of the genus, and to which it is probably most nearly allied. That species, a native of Java, is as yet only represented by the typical examples in the Leyden Museum, and these are so faded that little stress can be laid on their coloration. At the same time Dr. Jentink has kindly reexamined them at my request, and informs me that all the three skulls in that museum have four lower incisors as usual, that none of them have any trace of the minute extra molars in the upper jaw, and that, so far as he can tell, the wing-membranes are quite without the white spots present in *C. maculatus*.

Tupaia ferruginea longipes, subsp. n.

Hind feet conspicuously longer than in the typical Sumatran form. General colour less ferruginous above, but more so below; the shoulder-streak also, instead of being yellowish or whitish, is rich rufous. Upperside of tail concolorous with the back, instead of being markedly greyer.

Skull and teeth apparently as in the typical subspecies.

Dimensions of the type (a skin):—

Head and body 192 millim.; tail 190; hind foot 48·5.

Hab. N.W. Borneo. Coll. H. Low, 1876.

This long-footed form of *T. ferruginea* has been long known to me, and, as all the further specimens from the same region fully agree with Mr. Low's example, I take the present opportunity of describing it, and am only doubtful whether it should be described as a species or subspecies. The specimen which, on account of its having been the first collected, I have selected as the type, has no exact locality, but others since sent home by Messrs. Hose and Everett show the same elongate feet and define more precisely the range of the subspecies. Thus, there is a skin from Spitang, opposite Labuan (*Everett*), with a hind foot 48 millim. in length, one from Baram (*Hose*) of exactly the same length, and, finally, Mr. Everett has sent a full-grown male in spirit from Sarawak which presents the following dimensions:—Head and body 215 millim., tail 210, hind foot 52·5. The type specimen of *T. ferruginea typica* has a hind foot of only 42 millim., and this length does not appear to be exceeded by any other of our Sumatran or Malaccan examples.

It seems probable that this form represents *T. ferruginea* throughout Sarawak and Northern Borneo, and perhaps over the whole island, as I have seen no Bornean specimens of the usual Sumatran type.

Crocidura (*Pachyura*) *Hosei*, sp. n.

Size very small, scarcely exceeding that of the minute Indian species *C. Perotteti*, *Hodgsoni*, &c., and belonging evidently to the same group, which has not hitherto been recorded from the Malay region. Fur close, crisp, and velvety. Colour deep smoky grey, finely grizzled with whitish; belly rather paler; ears, feet, and tail dark brown. Tail very short and slender, closely haired, with a few longish hairs as usual scattered among the shorter ones.

Anterior part of first incisor short and thick; posterior cusp about equal in size to one of the two posterior unicuspids;

first unicuspid large, its tip reaching the same level as the first incisor and the tip of the large premolar; second and third unicuspids about equal in size, the second slightly longer but slenderer than the third; fourth well developed, its tip just visible externally, and about equal in height to the basal process of the large premolar and about half the height of the third. Anterior lower incisor long and slender, without denticulations; second lower unicuspid just exceeding in height the anterior cusp of the large premolar.

Dimensions of the type (an adult skin):—

Head and body (probably stretched) 59 millim.; tail 20; hind foot 8·6.

Front of $\underline{\text{i. 1}}$ to back of $\underline{\text{m. 3}}$ 6·4; breadth of palate outside $\underline{\text{m. 1}}$ 4·1, inside $\underline{\text{m. 1}}$ 1·6; distance from tip of $\underline{\text{i. 1}}$ to tip of the large premolar 3·1; length of lower tooth-row 5·8.

Hab. Bakong River, Baram, East Sarawak. Coll. Charles Hose, Dec. 1891.

This species is larger than any of the Indian pigmy shrews, while it is far smaller than any other Oriental *Pachyura* as yet described. Its short tail seems also to distinguish it from all its allies.

Mr. Everett has also collected a minute shrew in Sarawak, but it proves to be a true *Crocidura* (*s. s.*), and, judging merely from the description, I do not at present feel justified in distinguishing it from the Javan *C. monticola*, Pet.

Chiropodomys major, sp. n.

Colour and proportions very much as in *Ch. gliroides*, but size conspicuously greater, especially so far as the skull is concerned (see dimensions below). Upper surface fawn, the bases of the hairs slate-coloured; whole of lower surface pure white. Ears large, naked. Tail long, hairy, and pencilled as usual; uniformly brown above and below.

Skull with a flatter profile than in *Ch. gliroides*; anterior palatine foramina very short, ending half their own length in front of the molars. Molars broad and rounded.

Dimensions of the type (an adult female, stuffed):—

Head and body 100 millim.; tail 109; hind foot 21·5; ear from notch 14.

Skull: upper length 30; breadth of brain-case 14; length of nasals 10; interorbital breadth 5·3; interparietal, length 5·2, breadth 10·4; anterior zygoma-root 3·1; palate, length 15·2, breadth outside $\underline{\text{m. 1}}$ 5·8, inside $\underline{\text{m. 1}}$ 3·4; diastema 8·5; anterior palatine foramina 3·8; length of upper molar series 4·4.

Hab. Sadong, Sarawak. Coll. A. R. Wallace, Esq.

A second specimen from the same place agrees with the type in every respect.

Chiropodomys pusillus, sp. n.

Size smaller than in *Ch. gliroides*. Ears and feet decidedly smaller and tail shorter than in that species. Fur crisp, close and velvety. General colour tawny fawn, head and centre of back darker, sides paler, outer sides of arms and legs like back, but the wrists and ankles greyish, a colour which also extends upon the metatarsus; fingers and toes white; under surface from chin to anus pure white; no darker markings on face; ears small, evenly oval, practically naked. Tail but little longer than the head and body combined, uniformly brown above and below, its terminal tuft of hairs of about the same thickness, but less extended and commencing more abruptly than in the allied species.

Skull smaller and rather more delicately built than in the other species and showing even more markedly the roundness, simulating immaturity, characteristic of the genus; supraorbital bead but slightly developed; anterior palatine foramina very short. Molars small, their structure as usual.

Measurements of the type (skin):—

Head and body 76 millim.; tail 81; hind foot 15·8; heel to front of last foot-pad 7·2; ear from notch 11·5.

Skull: upper length 22·2; breadth of brain-case 11·6; nasals, length 7·2; interorbital breadth 4·2; interparietal, length 4·2, breadth 9·2; anterior zygoma-root 2·1; diastema 6·2; anterior palatine foramina 2·7; combined lengths of $\underline{\text{m. 1}}$ and $\underline{\text{m. 2}}$ ($\underline{\text{m. 3}}$ is unfortunately lost) 2·5; length of lower molar series 3·1.

Hab. Mount Kina Balu, 1000 feet.

This species is founded on the specimen referred by me in 1889[*] to *Ch. gliroides*, a reference mainly induced by the peculiar rounded and immature appearance of the skull; but this appearance has since proved to be a characteristic of the whole genus, and an examination of the teeth shows that the specimen is after all fairly adult. This being the case, the marked differences in the dimensions of the ears, feet, and tail will readily distinguish it from the older known species.

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[*] P. Z. S. 1889, p. 235.

Mus Margarettæ, sp. n.

Size, form, and general appearance very much as in *Vandeleuria oleracea*. Whiskers numerous and prominent, black. Ears small, oval, practically naked. Colour, so far as can be made out in a specimen in spirit, deep rufous chestnut, mixed on the back with the grey of the bases of the hairs, but clearing on the sides, where it seems to form a rufous lateral band. Chin, chest, and belly white. Hands and feet also white, but the metapodials with darker median patches. Thumbs prominent, opposable, with a large nail; claws of fingers short and curved. Hallux also opposable, its claw reduced to a minute conical point, not surpassing in length the pad below it; other toes all with their claws very short and curved, and surpassed in length by the prominent terminal pads. Soles naked, with six large rounded pads. Tail very long, slender, finely haired, almost naked; scales very small, averaging about seventeen to the centimetre, their colour a sort of pale greenish grey, the same above as below. Mammæ 1—2=6. Palate-ridges 3—5.

Skull with a very peculiar and noteworthy resemblance to that of *Chiropodomys*, agreeing with that of *Ch. gliroides* so closely that it is not until a close examination is made that the differences become apparent. General proportions short and broad, the brain-case especially broad and rounded. Interorbital space flat, its edges sharply beaded, converging strongly forwards. Interparietal very large, its anterior edge nearly directly transverse, its posterior one boldly bowed out backwards. Anteorbital plate of zygoma not projected forwards at all. Anterior palatine foramina very small and narrow. Molars of very much the rounded shape and general proportions of those of *Chiropodomys*, but their structure as in *Mus*.

Dimensions of the type (an adult female in alcohol):—

Head and body 76 millim.; tail 144; hind foot 19·7; ear, above head 11, from notch 13; length of head 28.

Skull: basal length 21·5; upper length 25·5; zygomatic breadth 13; breadth of brain-case 12·2; nasals, length 7·6; interorbital breadth 4·1; interparietal, length 4·2, breadth 9; anterior zygoma-root 2 3; palate, length 13; diastema 6·8; anterior palatine foramina 3·6; length of upper molar series 3·7.

Hab. Penrisen Hills, Sarawak. Coll. A. Everett, June 1892.

This very remarkable species will no doubt need in the future the erection of a special genus or subgenus for its reception, and will perhaps prove to be congeneric with *Mus chiropus*, lately described by me[*], which also has the molar teeth of *Mus* combined with an opposable hallux and a general *Chiropodomys-* or *Vandeleuria*-like form. Pending further investigation, however, I prefer to do as I did then, and leave the new form in the genus *Mus*.

I have taken the liberty of naming this beautiful little species, which looks as if it would make a most enchanting pet, in honour of Her Highness the Ranee of Sarawak, a lady whose interest in the zoology of that country is scarcely inferior to that of her husband the Rajah.

LVII.—*On a Small Collection of Land-Shells from Palawan and Balabac, Philippine Islands.* By EDGAR A. SMITH.

[Plate XVIII.]

THE British Museum has recently obtained a small collection of land-shells, collected by Mr. A. Everett in Palawan and Balabac. Of the thirteen species it contains five appear to be new. This large proportion of undescribed species is not altogether surprising, as neither of these islands has been thoroughly searched for Mollusca. A list of the known species was given by the Rev. A. H. Cooke in the Proc. Zool. Soc. 1892, pp. 461–463. It comprises the species quoted in the various papers by Hidalgo in the 'Journal de Conchyliologie,' 1887, pp. 36, 37–58, 93–192, 1888, pp. 30–97, and in Dohrn's "Beitrag zur Conchylienfauna des philippinischen Insel Palawan"[†].

Including the new *Lagochilus similis* here described fourteen species of land-mollusks have now been recorded from Balabac. The *Amphidromus quadrasi*, although appearing in Mr. Cooke's list, was not previously known from Balabac, but only from a small adjacent island called "Isla de Candaramanes" (*Hidalgo*). Another species from this island quoted by Hidalgo[‡] and not in Mr. Cooke's list of the Balabac shells is *Corasia zamboangæ*, Hombron and Jacquinot.

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[*] Ann. Mus. Genov. (2) x. p. 884 (1891), and p. 935 (1892), pl. xi. figs. 4–7.

[†] Nachrichtsblatt deutsch. mal. Gesell. 1889, pp. 53–63.

[‡] Mem. Acad. Madrid, 1890, vol. xiv. p. 151.

Thirty species are enumerated from Palawan or Paragua, and if *Euplecta boholensis*, Pfr., be distinct from *E. cebuensis*, Möllendorff, it will add one more to the total. It is quoted from Palawan by Hidalgo*, but not in Cooke's paper.

The most interesting addition to the fauna occurring in the present collection is the new species of *Lagochilus*, a genus hitherto unknown from Balabac or Palawan. It occurs, however, sparingly in other parts of the Philippine group and also to the south in Borneo &c.

1. *Macrochlamys pseustes*. (Pl. XVIII. figs. 1–3.)

Testa angustissime perforata, depressa, orbicularis, superne fusca, infra pallidior, nitidissima, subpellucida; anfractus 6, regulariter et lente crescentes, convexi, sutura profunda discreti, lineis incrementi supra distinctioribus quam infra sculpti, ultimus ad peripheriam acute rotundatus; spira brevissima, ad apicem obtusa; apertura oblique lunata; perist. tenue, margine columellari leviter incrassato, supra umbilicum angustissimum breviter reflexo.

Diam. maj. 21 millim., min. 19; alt. 10.

Hab. Palawan.

This species is remarkable for the convex whorls and the deep suture. It is of a rather rich brown colour on the upper surface, but considerably paler beneath. The lines of growth are rather strongly marked above, so that they present an almost subplicate appearance. The deep suture is bordered with a very narrow dark brown line, which, however, is not noticeable without a lens.

The genus *Macrochlamys* has not hitherto been recorded from Palawan, but there are several allied species found in North Borneo which have been placed in the section *Everettia* by Godwin-Austen (Proc. Zool. Soc. 1891, pp. 33–36).

2. *Lamprocystis chlororhaphe*. (Pl. XVIII. figs. 4–6.)

Testa parva, angustissime perforata, depresse conoidea, tenuis, pellucida, nitida, cornea; anfractus 5–6, lente accrescentes, convexiusculi, infra suturam anguste albido-marginati, vix striati, ultimus ad peripheriam acute rotundatus; spira breviter conoidea, ad apicem obtusa; apertura oblique lunata; peristoma simplex, margine columellari leviter incrassato, sed vix reflexo.

Diam. maj. 6 millim., min. $5\frac{1}{4}$; alt. 4.

Hab. Palawan.

The minute perforation and the palish line at the suture

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* *L. c.* p. 85.

are the most noticeable features of this little species. It is about the same size as *L. lucidella*, Pfr., but differs from it in having the body-whorl narrower, the columella less reflexed over the perforation, and the suture narrowly margined with white.

3. *Trochonanina paraguensis.* (Pl. XVIII. figs. 7–9.)

Testa imperforata, depresse conoidea, acute carinata, unicolor, cornea, vel interdum utrinque carinam anguste fusco zonata; anfractus 7–8, superne vix convexiusculi, lente et regulariter crescentes, incrementi lineis oblique arcuatis striisque spiralibus paucis sculpti, ultimus haud descendens, acute carinatus, infra convexus, haud spiraliter striatus; carina supra et infra vix compressa: apertura angusta; peristoma album, magnum, margine supero leviter incrassato et subexpanso, basali fortius incrassato.
Diam. maj. 18½ millim., min. 17; alt. 8.

Hab. Palawan.

This species is closely allied to *T. labuanensis*, Pfeiffer. It may be distinguished by the spire being rather less elevated, the keel not so acute and not compressed above or below; the umbilical region is not so impressed, and the peristome, especially the basal margin, is distinctly thickened. This species is much more distinct from *T. labuanensis* than the latter is from *T. conicoides*, Metcalfe, which indeed are considered synonymous by Godwin-Austen. *T. conicoides*, however, has a more elevated and conical spire than *labuanensis*, and the coil of the whorls is different, so that in the latter the last whorl seen from above is conspicuously narrower than in *conicoides*.

T. sylvana, Dohrn and Semper, has a higher spire than *paraguensis*, a sharper and more compressed keel, and has not the basal lip of the aperture thickened. It is all but identical with *labuanensis*.

4. *Trochomorpha Metcalfei*, Pfr.

Hab. Palawan (*Hidalgo*, *Everett*).

This species is very variable and is met with on several of the islands of the Philippine group. With Hidalgo (*l. c.* p. 112) I agree in considering *T. boholensis* of Semper as a variety.

5. *Hemiplecta densa*, var.

The variety of this species from Palawan, namely that described by Pfeiffer as *Helix Schumacheriana*, has already been quoted by Dohrn (Nachrichtsbl. deutsch. mal. Gesell. 1889, p. 57).

Two forms of it were obtained by Mr. Everett, also in Palawan, one in which the last whorl is much more acutely keeled and more finely sculptured beneath than in the other. Considerable variation in these respects occurs also in the Bornean examples in the British Museum. The very acute specimens from Palawan are very like *H. cymatium* of Benson from Penang. Two specimens of the latter, marked in Pfeiffer's handwriting from Pulo Zancavi, Malacca, appear to me quite inseparable from the present species, but two others from Penang, presented by Mr. De Burgh, although very like the var. *Schumacheriana*, appear to have an additional whorl and to be less rapidly coiled, so that the last is narrower than in the Bornean shell.

6. *Helix* (*Hadra*) *Traillii*, Pfeiffer.

The typical form of this species is more conical than the specimens obtained at Palawan by Mr. Everett, and much more coarsely striated. The transverse bands also are not nearly so dark-coloured as in the specimens just received. Most of the latter are covered with a thin bright yellowish epidermis, with which the dark zones contrast strongly. They vary considerably in the elevation of the spire, but none are so depressed as *H. monochroa* or its variety *palawanica*. Occasionally the ground colour above is of a dark reddish tint. The bands on the body-whorl are usually four in number, namely a narrow one at the suture, a broader one at the periphery, a still broader one below it, and a faint one above it. The last is sometimes absent.

7. *Cochlostyla satyrus*, Broderip.

The series sent home by Mr. Everett from Palawan confirms the opinion of Dohrn and Cooke that *C. palawanensis*, Pfr., *C. cinerosa*, Pfr., *C. librosa*, Pfr., and *C. Graellsi* of Hidalgo are mere varieties.

Mr. Everett also obtained this species at Banguey Island, situated between Borneo and Palawan.

8. *Amphidromus quadrasi*, Hidalgo.

(Pl. XVIII. figs. 10–13.)

Amphidromus quadrasi, Hidalgo, Journ. de Conch. 1887, p. 36, pl. ii. fig. 2.

Hab. Balabac (*Everett*); island of Candaramanes or Caramandanes, near Balabac (*Hidalgo*).

Numerous specimens of the typical form of this species were collected by Mr. Everett, besides a number of other forms which probably merely indicate colour-variation. They may be thus described :—

a. Green, with a deep rose-coloured band at the suture and around the base of the lilac columella (typical form). (Fig. 10.)

b. Yellow, with similar band at suture and base; columella lilac.

c. Yellow, without sutural band, with a broad green band on the back of the body-whorl behind the lip; columella pale pink. (Fig. 11.)

d. Uniformly yellow, faintly streaked with green; columella white.

e. Yellow, with the spire ornamented with oblique, wavy, rich brown lines, forming blotches above the suture, and with a similar green band as in the preceding form; columella pale pink. (Fig. 13.)

f. Very dark chestnut, almost black, but pale at the suture, with oblique wavy white streaks, which are interrupted at the middle of the body-whorl. A yellowish zone occurs below the periphery and a pinkish one around the base of the columella. The lip is blackish and the columella bluish white. (Fig. 12.)

The above are a few variations in colour illustrated by six specimens selected from a hundred. Other slight variations were observed in many other examples. The ground-colour varies from bright green to bright or pale yellow, with all shades of intermediate tints. The form *f*, of which there was but one specimen, is most strikingly abnormal. It has a black lip, whereas in all the rest it is white. However, in two specimens in the Museum marked Borneo, which I believe belong to this species, it is almost black.

Similar great differences in colour occur in *A. Adamsii*, Reeve.

9. *Opisthoporus quadrasi*, Hidalgo.

Hab. Palawan (*Hidalgo, Dohrn, and Everett*).

10. *Leptopoma vitreum*, Lesson.

Several varieties of this species occur in Palawan. Some are white with fine pellucid spiral lines; in others the latter are pale brownish and more or less interrupted or dotted, and the variety named *L. bicolor*, Pfr., is also among the specimens sent by Mr. Everett, who also obtained a similar series of varieties at Balabac.

11. *Leptopoma palawanensis*. (Pl. XVIII. figs. 20, 21.)

Testa turbinata, umbilicata, mediocriter tenuis, albida, epidermide tenui flavescente induta, flammulis obliquis irregularibus nigrofuscis subconfertis supra picta, infra peripheriam lineis angustioribus zigzag-formibus et zona saturatiore prope medium ornata; spira conica, mediocriter acuta; anfractus 5½, primi 1½ flavescentes, sequentes duo saturate fusco-purpurei, omnes convexi celeriter crescentes, spiraliter distanter lirati vel carinati, ultimus in medio subangulatus, postice carinatus (carina versus aperturam sensim obsoleta), supra peripheriam carinis subæquidistantibus tribus cinctus, infra medium fere lævis; apertura haud circularis, triangulariter rotundata; peristoma album, leviter expansum, margine columellari arcuato, recedente, superne callo tenui labro juncto.

Diam. maj. 18 millim., min. 14; alt. 15½. Apertura cum perist. 10 lata, 9½ longa.

Hab. Palawan.

Perhaps *L. regulare*, Pfr.*, is nearer this species in some respects than any other yet described. It is, however, considerably smaller and has more numerous keels. It is also taller in proportion to the width and has a rounder mouth.

Besides the spiral keels in the present species, faint traces of intermediate spiral striæ are observable, and the lower part of the body-whorl not unfrequently exhibits a slender raised line at a little distance from the more pronounced central carina.

12. *Lagochilus similis*. (Pl. XVIII. figs. 14–16.)

Testa *L. ciliato* similis, sed major, lævior, haud spiraliter striata, inferne haud picta; anfractibus superioribus fortius carinatis, umbilico carina vel angulo haud circumdato.

Diam. maj. 16 millim., min. 12½; alt. 13. Apertura cum perist. 8 alta et lata.

Hab. Balabac and Palawan.

This species, although so very like *L. ciliatum* of Sowerby†,

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* Reeve's Conch. Icon., *Leptopoma*, figs. 14–14 *b*.

† Thesaurus Conch. vol. i. p. 127, pl. xxx. figs. 237, 238; Pfeiffer, Conch.-Cab. ed. 2, *Cyclostoma*, p. 150, pl. xx. figs. 26–27; Reeve, Conch. Icon., *Leptopoma*, pl. vii. fig. 39.

may be distinguished thus:—It is larger and has a more glossy appearance, caused by the absence of the fine spiral striæ which mark the surface of that species. The flame-like painting which ornaments the upper surface never extends beyond the periphery, the base being of a uniform light or dark horny tint.

In the three specimens of *L. ciliatum* in the Museum collection the base and especially the umbilicus exhibit vivid flammulations. Also two out of these three specimens have a strong carina bordering the umbilicus, a feature entirely wanting in all the examples of the present species. In the latter the peripherial keel revolves up the spire and is visible just above the suture, and a second thread-like carina occurs upon the middle of the penultimate and two preceding whorls, but is almost obsolete upon the last. In *L. ciliatum* these keels or liræ are much less conspicuous.

The ground-colour varies from reddish to whitish horn-colour, and the amount of flame-like painting upon the upper surface is more or less extensive, in some cases forming merely a series of blotches at the suture.

The typical examples of *L. ciliatum* were obtained in the island of Luzon by Mr. Cuming; but the occurrence of the species in the Philippine Islands has not since been confirmed.

13. *Cyclotus euzonus*, Dohrn. (Pl. XVIII. figs. 17–19.)

Hab. Palawan (*Dohrn and Everett*).

A single specimen of this species was obtained by Mr. Everett, differing from the type in being entirely of a chestnut-colour with the exception of a yellow narrowish zone at the periphery. In form this species exactly resembles *C. Boxalli* of Godwin-Austen, from North Borneo, but may be distinguished by difference of colour and its smooth thin epidermis, which, in the Bornean shell, is thick, opaque, and striated.

EXPLANATION OF PLATE XVIII.

Figs. 1–3. *Macrochlamys pseustes.*
Figs. 4–6. *Lamprocystis chlororhaphe.*
Figs. 7–9. *Trochonanina paraguensis.*
Figs. 10–13. *Amphidromus quadrasi.*
Figs. 14–16. *Lagochilus similis.*
Figs. 17–19. *Cyclotus euzonus.*
Figs. 20, 21. *Leptopoma palawanensis.*

LVIII.—*On new Japanese Coleoptera* (Silphidæ)*.
By G. Lewis, F.L.S.

In 1881 I had about thirty beetles given to me by Mr. Snow, who had, in an interval of seal-shooting, gathered them a short time before on the sea-beach of Ketoi, one of the smaller islands of the Kurile group. There were four or five specimens of *Nebria Snowi*, Bates, a few examples of *Geotrupes lævistriatus*, Motsch., some Curculionidæ, and the rest of the specimens belong to the genus *Lyrosoma*. The last are now described here, together with two species in the allied genera *Pteroloma* and *Pelates* taken by myself on the main island of Japan. The fauna of the Kurile Islands is doubtless a very limited one; but the discovery of four species of *Lyrosoma* amongst so few specimens shows it to be one of a very peculiar character.

List of Species.

Lyrosoma tripartitum.
—— Snowi.
—— suturale.
Lyrosoma ovipenne.
Pteroloma discicolle.
Pelates striatipennis.

Lyrosoma tripartitum, sp. n.

Rufo-brunneum, subopacum; antennis pedibusque concoloribus; capite inter oculos carinato.
L. $6\frac{3}{4}$–7 mill.

Reddish brown, elytra somewhat darker; the head, area before the eyes and the epistoma are flat and on the same plane, posterior limit of this area semicircular in outline; between the epistoma and the head is a distinct suture, which is joined to a longitudinal carina between the eyes, thus dividing the upper surface of the head into three parts, surface of head somewhat opaque, owing to a very fine sculpture; the thorax widest before the middle, and from the middle narrowed to the hind angles, angles a little obtuse, behind the neck is a rather wide median impression, surface microscopically sculptured, uneven, with a few irregular and ill-defined punctures; the scutellum triangular, very minutely and transversely rugose; the elytra margined laterally, margin and first stria leave a rather wide interstice from

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* For the first part of the "Silphidæ of Japan" see Ann. & Mag. Nat. Hist. 1887, xx. p. 338.

behind the humeral angle to the apex; striæ feebly punctulate, interstices flat, with a fine sculpture, which renders them opaque.

Hab. Ketoi. Under stones on the shore.

Lyrosoma Snowi, sp. n.

Obscuro-brunneum vel piceum; capite inter oculos subarcuatim elevato, irregulariter punctato.

L. 6 mill.

Dull reddish brown or piceous, head distinctly darker, legs, antennæ, and thorax concolorous; the head is irregularly and rather roughly punctured, with the median carina and the suture, as noted in *L. tripartitum*, scarcely visible, but between the eyes there is a crescent-shaped elevation; the thorax more distinctly punctured than in the last species and less narrowed behind, with the hind angles less obtuse, impressed behind the neck; the scutellum slightly arched at the sides and densely and distinctly sculptured; the elytra margined laterally, lateral interstice narrow and continuing to the base, striæ very feebly punctulate, interstices somewhat less flat than in *L. tripartitum*.

Hab. Ketoi.

Lyrosoma suturale, sp. n.

Rufo-brunneum, vix nitidum, sparse sed distincte punctatum; elytris piceis, interstitiis internis rufo-brunneis.

L. 4½ mill.

Reddish brown, somewhat shining; the head uneven, with two rather large shallow impressions on each side near the insertion of the antennæ, distinctly punctured in certain places, most free from points on the disk; the thorax punctured and uneven like the head, hind angles slightly acute, less distinctly narrowed behind than in *L. Snowi*, impressed behind the neck; the scutellum triangular, wholly sculptured, with a few rather large punctures scattered over it; the elytra are piceous, except on the two sutural interstices, the striæ distinctly punctate, especially in the scutellar area; the lateral interstice is narrow and ceases before the apex.

Hab. Ketoi.

Lyrosoma ovipenne, sp. n.

Rufo-brunneum, vix nitidum; elytris oviformibus, striis obsoletis punctatis.

L. 5 mill.

Reddish brown, somewhat shining, elytra a little darker; the head uneven above and irregularly punctured; the thorax widest about the middle, uneven and punctured like the head, impression behind the neck shallow, in one example almost effaced; the hind angles are obtusely rectangular; the scutellum triangular, feebly arched at the sides, wholly sculptured on surface, with a few punctures dispersed over it; the elytra are ovate, marginal interstice narrow and of even width throughout; striæ obscurely punctured, interstices densely sculptured and feebly rugose or uneven.

Hab. Ketoi.

The sculpture noticed in these species is peculiar to the genus; when it is feeble it resembles the surface of tanned leather, when dense and well-marked, as it is on the scutellum of *L. Snowi,* it resembles the sculpture so familiar to entomologists on the wing-cases of *Agrili.*

Pteroloma discicolle, sp. n.

Rufo-brunneum, vix nitidum; thorace disco nigro, angulis anticis prominentibus.

L. 4 mill.

Reddish brown, somewhat shining; epistoma and disk of the thorax black or piceous; the head impunctate but uneven; thorax, the hind angles rectangular, sides feebly bowed, anterior angles prominent, the thorax being cut out in front to receive the head; the disk is black and convex, the sides longitudinally impressed and spread outwards; the scutellum triangular and without sculpture; the elytra, margin elevated, marginal interstice narrow, the second and third striæ from the outer margin join at the base, the striæ are somewhat fine and punctulate; the wing-cases are wider than the thorax at the base, with a somewhat elliptical outline to the base.

I have one example, evidently a variety, in which the antennæ, head, and legs are infuscate.

Hab. Main island. I took six or seven specimens from under small stones on the summit of Nantaisan, 20th August, 1881.

Pelates striatipennis, sp. n.

Oblongo-ovatus, rufo-brunneus, nitidus; thorace conspicue punctato; elytris punctato-striatis.

L. $5\frac{3}{4}$–6 mill.

Oblong-oval, reddish brown or piceous, but with the margin of the thorax and elytra paler; the head sparsely punctulate, with the median area a little raised; the thorax convex behind the neck, transverse, arched at the sides, anterior angles obtuse, lateral margin narrow, very clearly punctured, punctures least close on the disk; the elytra punctate-striate, striæ deep and well-marked; the legs, palpi, and antennæ are concolorous with the paler parts of the body.

Hab. Main island. At Nikko an old tree, rotten as touchwood and ivy-grown, yielded eight specimens. Single examples were taken fortuitously in other places by beating foliage.

LIX.—*Description of the Skull of* Pisodus Oweni, *an* Albula-*like Fish of the Eocene Period.* By A. Smith Woodward, F.L.S.

[Plate XVII.]

It is now a well-established fact that many types of Teleostean fishes have undergone very little change since the Eocene, or even since the latter part of the Cretaceous period. Several well-defined genera seem to date back thus far, and others are represented by forms that differ in but small particulars. Moreover, a few of the most remarkable specializations in piscine skeletal anatomy characterizing the existing fauna are already recognizable in certain closely related Eocene types, and the progress of discovery is continually adding to the number of known examples. A most striking new case has lately been met with by the present writer among the fishes from the London Clay (Lower Eocene), and this forms the subject of the following notes.

So long ago as 1845 Sir Richard Owen described and figured the tritoral dentition of an unknown fish from the London Clay of the Isle of Sheppey under the name of *Pisodus Oweni* (ex Agassiz, MS.)*. The original specimen is preserved in the Museum of the Royal College of Surgeons, and exhibits an ovate pavement of small rounded or polygonal teeth firmly fixed in shallow sockets upon a plate of true bone. Appearances suggested to Sir Richard Owen that the fossil had been attached "to another bone of the skull, most probably, as in the *Glossodus* and *Sudis*, to a median bone of the hyoid system." Agassiz, who first examined the specimen,

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* R. Owen, 'Odontography,' p. 138, pl. xlvii. fig. 3 (1845).

supposed it might pertain to a so-called Pycnodont Ganoid *; and in Owen's 'Palæontology' (edit. 2, 1861, p. 174) *Pisodus* is also doubtfully quoted as a "Ganoid" of uncertain position.

It now appears from a nearly complete skull in the British Museum that the problematical fossil in question is the parasphenoid dentition of a fish remarkably similar in cranial characters to the recent Clupeoid *Albula*. The fact has already been incidentally mentioned in a record of the discovery of *Pisodus* in the Middle Eocene of Belgium †; and it only remains to justify, by a detailed description and figures, the recognition of an *Albula*-like fish at so remote a period as that of the Lower Eocene. Dr. Shufeldt's admirable description of the skull of the recent *Albula vulpes* fortunately suffices for requisite comparison ‡.

The fossil skull in question is imperfectly preserved in several respects, though exhibiting most of the principal characters. It is shown of one half the natural size, from four aspects, in the accompanying Plate XVII. The rostral region is wanting, the projecting lateral portions are broken away, and the basioccipital and basisphenoid bones are in great part removed by fracture. The general form of the cranium, however, is recognizable, and the great expansion of the parasphenoid, with its tritoral dentition, is especially well displayed. The cranial roof (fig. 1) is flattened and terminates abruptly behind in a straight occipital border. The occipital face (fig. 2) is nearly vertical; and the basioccipital axis is approximately parallel with the cranial roof, meeting the dentigerous portion of the parasphenoid in a sharp angulation (fig. 4).

On the occipital face (fig. 2) the two exoccipital elements (*ex.occ.*) are observed immediately above the foramen magnum (*f. m.*), and seem to have been originally apposed in the median line except at their upper extremity. These bones are deeper than broad, so far as preserved, quadrilateral, and with a slightly concave outer surface. Their superior internal angles are truncated for the reception of the lower end of the large triangular supraoccipital (*s.occ.*), which is flattened, but shows remains of a **T**-shaped, backwardly directed, mesial crest (*c*) in its upper two thirds.

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* L. Agassiz, Poiss. Foss. vol. ii. pt. ii. p. 247 (1844).

† Smith Woodward, "Notes on some Fish-remains from the Lower Tertiary and Upper Cretaceous of Belgium," Geol. Mag. [3] vol. viii. p. 108 (1891).

‡ R. W. Shufeldt, "The Osteology of *Amia calva* &c.," Ann. Rep. U.S. Fish Commission, 1883, pp. 61–67, pls. xii., xiii.

The supraoccipital bone also appears as a narrow band at the hinder margin of the cranial roof (fig. 1, *s.occ.*) bordering the pair of very short and broad parietal elements (*pa.*). These bones are not symmetrical, the mesial suture being bent and distorted to the right. They are much smaller than the squamosals (*sq.*), of which that of the left side is preserved to a large extent. The frontal bones (*fr.*) are relatively enormous, and all the smaller roof-bones by which they would be bounded laterally and anteriorly are unfortunately removed. While for the most part flat, this pair of bones is mesially depressed in the hinder two thirds of its extent, and thus originates a great hollow gradually deepening forwards to a sudden termination.

Of the bones in the otic region only portions of the pro-otic and opisthotic remain, and these are not sufficiently well preserved for description.

The three teeth displayed in their sockets in the parasphenoid bone (fig. 3, *pas.*) have been much worn during the life of the fish, all the gano-dentine being removed from the top of the flattened crown.

Nothing further need be added to indicate how closely the cranium thus described resembles that of *Albula* treated by Dr. Shufeldt in the memoir already referred to. So far as preserved the fossil agrees with the recent skull even to minute particulars, and, apart from size, there is little to indicate specific, much less generic, differences. The rostral region may, however, have presented a different configuration from that of the existing *Albula*; and in the absence of all knowledge of the trunk it is impossible to arrive at any definite generic determination. The Eocene fish from Sheppey must therefore retain its provisional name of *Pisodus Oweni*, and the description of the skull now published merely establishes its family position.

EXPLANATION OF PLATE XVII.

Pisodus Oweni, Owen (ex Agassiz, MS.). Skull shown from four aspects, one half the natural size.—London Clay, Isle of Sheppey. [Brit. Mus. no. 39439.]

Fig. 1. Cranial roof. *c*, base of crest on supraoccipital; *fr.*, frontal; *pa.*, parietal; *s.occ.*, supraoccipital; *sq.*, squamosal.

Fig. 2. Outline of occipital face. *ex.occ.*, exoccipital; *f. m.*, foramen magnum.

Fig. 3. Base. *pas.*, parasphenoid, showing three teeth and sockets of others.

Fig. 4. Side view. *orb.*, position of eye.

LX.—*On the Formation of the Germinal Layers in Vertebrates.* By Basilius Lwoff, of Moscow University*.

Extensive comparative investigations upon the formation of the germinal layers in Vertebrates have led me to conclude that all the theories at present prevailing on the subject of gastrulation and germinal-layer-formation in this division of the animal kingdom are not in accordance with the facts. All these theories regard the invagination, which is characteristic for all Chordata, as nothing else than gastrulation, although in the majority of cases this invagination bears no relation to the formation of the intestine. The consequence of this is that in the higher Vertebrata we have nothing to help us to distinguish the primary germinal layers. Starting from the conviction that the true endoderm is always formed by invagination, authors have proceeded so far in this direction as to regard the lower layer in the case of the Amniota, from which the intestine is formed and which is homologous with the endoderm of the lower Vertebrates, not as the endoderm, but as something that admits of no homology with what is found in the lower Vertebrates (paraderm &c.); as endoderm, however, are designated the ectoderm cells which are invaginated or grow inwards, but take no part in the formation of the intestine. Or, again, it is assumed that both the cells of the lower layer, from which the intestine is formed, and the invaginated ectoderm cells are to be considered as endoderm; but the lower layer, from which the intestine arises, is designated secondary or cenogenetic endoderm, while to the invaginated cells, which represent the rudiment of the notochord and mesoderm, the term primary or palingenetic endoderm is applied. It therefore follows according to this interpretation that the intestine is formed from the cenogenetic and the notochord from the palingenetic endoderm. In order to realize how untenable this conception is we need only ask which is phylogenetically the older, the intestine or the notochord?

Since we would regard the process of invagination which is characteristic of all Vertebrates as gastrulation in its original simplicity, it is natural that we should desire to discover a gastrula mouth in these supposed gastrulæ also, and to determine in all Vertebrates the homology of the dorsal and ventral lips of the blastopore. But the views of

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* Translated from the 'Biologisches Centralblatt,' xiii. Bd., no. 2, Feb. 1, 1893, pp. 40-50; and no. 3, Feb. 15, 1893, pp. 76-81.

different investigators with reference to these questions are so very divergent as to furnish the best proof of the vagueness of the conceptions as to what is to be designated as gastrulation. Just as many differences of opinion prevail on the subject of the gastrula mouth. According to the view of certain embryologists the blastopore in meroblastic ova corresponds to the margin of the epibolic growth which surrounds the yolk. Other embryologists, on the contrary, insist that the margin of the epibolic growth in no way corresponds to the blastopore; they maintain that it is a peculiarity of meroblastic ova, and so forth. It is proposed by this school to designate as blastopore that spot in the germ at which an invagination of cells takes place (in the Selachians the posterior portion of the margin of the germinal disk, in the Amniota the primitive streak and the primitive groove). But this is not all. There are also embryologists who assume that the blastopore is always turned towards the neural side of the animal, where it closes up along a median line, which is termed the gastrula suture ("Gastrularaphe"). In this manner, according to this conception, the nervous system develops in the place of the gastrula suture, since the margins of the blastopore become transformed into the medullary folds!

In this brief communication it is indeed impossible for me to enter into a discussion of all the theories which trace the corresponding developmental processes of Vertebrates to gastrulation, or which, in other words, would discover in gastrulation a universal explanation of the formation of germinal layers, as though no other processes could exist in these stages. Many attempts have been made to apply the gastrulation theory in the case of all Vertebrates, but all these theories are in my opinion forced and unnatural. We have yet to inquire whether it is not possible to interpret these processes somewhat differently without unduly extending the range of the theory of gastrulation.

My investigations have led me to the conclusion that a conception such as regards the process of invagination not as gastrulation, but as a phenomenon which is characteristic of all Chordata, is not merely possible, but is absolutely necessary, if we would compare the earliest developmental processes of different Vertebrates one with another, and at the same time retain the strict homology of the primary germinal layers. I have studied the formation of the germinal layers in the following animals :—*Amphioxus* and *Petromyzon*; *Axolotl*, among the Amphibians; *Pristiurus* and *Torpedo* among the Selachians; *Labrax*, *Julis*, and *Gobius* among Teleostean fishes; and *Lacerta* among the Reptiles. My investigations upon the development of *Amphioxus* have already been published*. In the following pages it is my intention to describe the results of my studies upon these developmental processes in the above-mentioned Vertebrates, so far as is necessary in order to establish my theory. Although I owe this theory just as much to an attentive study of the literature of the subject as to my own investigations, I shall nevertheless in the present paper leave the literature almost entirely out of the question, in order not to overstep the limits of a provisional communication. The discussion of the literature dealing with the subject, as well as the full description of my investigations, will follow in a detailed paper which is shortly to appear.

Before proceeding to the account of my results I would draw attention to certain points which are of importance in this question. In the first place let us consider whether the school which is at present predominant is correct in regarding the invagination in Vertebrates as gastrulation. In order to answer this question it is necessary to ascertain what is actually to be understood by the term gastrulation, and to discover what portion of the process is typical and what is adventitious and unessential.

Gastrulation is the term which was applied to the process of invagination which leads to the formation of the enteric cavity, whereby a distinct gastrula is constituted. But the process of the formation of the intestine is not always accomplished by means of invagination; it often happens that this process takes place in such a way that the cells which subsequently form the intestine (endoderm cells) are overgrown by the external (ectoderm) cells, and the enteric cavity afterwards arises through divergence of the endoderm cells. This process of enveloping growth is regarded by many investigators as homologous with typical gastrulation, and, as I think, justly, since in both cases the process essentially consists in the fact that the endoderm cells which constitute the intestine come to lie in the interior, and are surrounded by the cells of the ectoderm. Whether this process is accomplished in the form of invagination or of enveloping growth is of subordinate importance. It follows from this that the only process which can be designated as gastrulation is that by which the endodermal elements are invaginated or overgrown, by which consequently above all the formation of the intestine is ushered in. We must hold fast to this con-

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* Biol. Centralblatt, Bd. xii. nos. 23 and 24.

ception if we would believe that gastrulation has any definite meaning at all. This is the first point to be considered in this important question.

The second point concerns the discrimination of the primary germinal layers. If we would derive the bilaterally symmetrical Chordata from a Gastrula-like form with radial symmetry we must adhere to the homology of the ectoderm and endoderm of such a Gastrula-like form with the external and internal germinal layers of the Chordata. Since, however, the endoderm of the Gastrula-like form in the first place gives rise to the intestine, our first step in the determination of the germinal layers is to elucidate the question by what elements or what layer the intestine is formed. To this layer the term endoderm must be applied, it matters not whether something besides the intestine is formed from these cells or not.

I will not here enter into the question whether typical gastrulation, *i. e.* invagination, represents a primary or a secondary mode of formation of the endoderm. Nevertheless, in the interpretation of the conditions which are found in Vertebrates I assume that the bilaterally symmetrical Chordata are derived from a Gastrula-like form with radial symmetry, since in the development of the lower Chordata it is impossible not to recognize a gastrula, although a somewhat modified one. At the same time, in homologizing the germinal layers of the Chordata we must not lose sight of our thesis, that the inner layer (the endoderm) of the gastrula forms the intestine, while the ectoderm constitutes the outer covering; otherwise the homologization loses all its meaning. Therefore we shall designate as endoderm cells those from which the intestine arises, no matter whether something else is also formed from these cells or not.

If from this point of view we compare the conditions which exist in *Amphioxus* and the Vertebrates, we arrive at the following results :—The segmentation of the ovum proceeds in such a way that in holoblastic ova, as a result of the segmentation, we get a blastula, one half of which is composed of smaller blastomeres (micromeres) and the other of larger blastomeres (macromeres). The difference between the micro- and macromeres has arisen in consequence of the fact that the former multiply more rapidly than the latter. Since the more rapid multiplication of the micromeres also continues after the formation of the blastula, the micromeres commence to spread out over the macromeres and to grow round them. In cases where we find a single-layered blastula (in *Amphioxus*) this process takes place in such a way that the macromeres become invaginated; where the blastula consists of several layers (as in *Petromyzon* and Amphibia) the micromeres simply grow round the macromeres. Since these macromeres form the intestine, they may with perfect justice be designated as endoderm cells; the micromeres, on the contrary, which differ noticeably from the macromeres and give rise to the outer covering, are to be termed ectoderm cells. I see no reason to distinguish an ectodermal and an endodermal half after the first divisions of the ovum have taken place, or it may be after the first equatorial furrow (as is the practice of certain investigators). Such a distinction seems to me to be lacking in foundation at this stage, since each supposed endoderm cell of this kind may divide into two or more cells, of which one will subsequently become an ectoderm cell by position, while the other will belong to the endoderm. The distinction of the ectoderm from the endoderm is only possible when the blastula is already formed and the macromeres are being overgrown by the micromeres. In this connexion it makes no difference whether the macromeres are invaginated or are overgrown by the smaller cells. I term them endoderm cells not on account of invagination, but merely because they form the intestine. But the process in consequence of which the endoderm cells come to lie within and become surrounded by the cells of the ectoderm can be homologized with that of gastrulation. This process is to be regarded as preparatory to the formation of the intestine. But besides this process of gastrulation, by which the formation of the intestine is ushered in, there appears on that side which subsequently becomes the dorsal side of the animal another process, which represents the invagination of the ectoderm cells, and which I will term the dorsal invagination. **This dorsal invagination is quite independent of the gastrulation, and has nothing to do with the formation of the intestine; it gives rise to the common ectoblastogenous rudiment of the notochord and the mesoderm.**

This conception, which was mainly arrived at in the investigation of the development of *Amphioxus*, *Petromyzon*, and *Axolotl*, I was also able to follow out in the interpretation of the developmental processes of the Teleosteans and Selachians, and it is moreover confirmed in the clearest manner by the development of the Amniota.

After these preliminary remarks I will proceed to the account of my results.

My investigations upon the formation of the germinal layers in *Petromyzon* commence with the stage of the blastula. The blastula includes an excentric cavity, lying nearer the upper pole, the roof of which is constituted by smaller blastoderm cells and the floor by several layers of larger cells, richer in yolk, which develop into endoderm. I was also able to observe the multiplication and extension of the blastoderm (ectoderm) cells over those richer in yolk (endoderm cells). Numerous mitoses may be observed in the ectoderm cells. I counted the mitoses in a series of sections through a stage of this kind, and found that the endoderm cells contained five and the superficial ectoderm cells twenty-three mitoses. In this manner smaller ectodermal cells surround the larger endodermal elements, which thus come to lie within and become enveloped by the former. Simultaneously with this on one side, which becomes the dorsal surface of the embryo, a particularly active multiplication of the ectoderm cells may be noticed, and here, at a spot which marks the posterior end of the embryo, the invagination of the ectoderm cells commences. By this means a cavity is formed, which is usually termed the cavity of the gastrula, or archenteron, and the dorsal wall of which is constituted by the invaginated ectoderm cells. But this invagination forms only the dorsal wall of the cavity, and I therefore term it the dorsal invagination. The ventral wall of the cavity is formed by the endoderm cells, which are not invaginated, but were previously situated here. These conditions can be seen with great distinctness in median sections through stages of this kind. In such sections we observe that the ectoderm cells grow inwards from the dorsal margin of the enveloping layer, and form the dorsal wall of the cavity; the ventral wall, on the other hand, is formed by the cells of the endoderm. We also observe the different character of the cells of the dorsal and ventral walls. The former are arranged in epithelial fashion, and form the continuation of the ectoderm cells, which grow inwards from the margin of the enveloping layer. The cells of the ventral wall of the cavity have a roundish or polyhedral form, and are not arranged in epithelial fashion. They acquire the regular epithelium-like character later on, when the intestine arises from them. In the enumeration of the mitoses in a series of sagittal sections it was found that the endoderm cells contained four (chiefly in the anterior portion of the cavity), the ectoderm cells twenty-four (chiefly upon the dorsal side; among these were seven at the margin of the enveloping layer), and the invaginated ectoderm cells four mitoses.

I must lay quite special emphasis upon the fact that the endoderm cells which subsequently form the intestine are not invaginated; they only experience certain displacements in consequence of the dorsal invagination, whereby the segmentation cavity becomes obliterated. Elements alone are invaginated from which the notochord and the mesoderm arise, and moreover this invagination takes place in such a way that the ectoderm cells grow inwards from the margin of the enveloping layer and form the continuous dorsal plate, the ectoblastogenous rudiment of the notochord and mesoderm. I see no reason for designating the cells of the dorsal wall of the cavity as endodermal, merely because they grow inwards (become invaginated). Similarly I see no reason for terming the cavity at this stage the gastrula or archenteric cavity. At this stage an enteric cavity is not yet present: it is constituted subsequently, when the endoderm cells diverge one from another and form the epithelial wall.

From the central portion of the dorsal plate is differentiated the rudiment of the notochord; the two lateral portions, together with the adjoining cells of the endoderm, form the rudiments of the mesoderm. As a rule no sharp dividing line can be drawn between the ectoblastogenous and endoblastogenous cells of the mesoderm, for the cells which are invaginated grow inwards, while they closely adjoin the cells of the endoderm. After the rudiment of the notochord has separated off from the lateral mesodermal rudiments, the margins of the endoderm grow towards one another, to close the enteric wall; but before this takes place the rudiment of the notochord is temporarily included in the dorsal wall of the intestine. Since the margins of the endoderm continue to grow beneath the notochord, the latter is excluded, the edges of the endoderm unite, and the enteric cavity closed on all sides is now constituted.

I was able to observe the same developmental processes in the case of *Axolotl* also. In this case certain points tell even more in favour of my conception than in *Petromyzon*. While the larger endoderm cells are being overgrown by the smaller ones of the ectoderm the dorsal invagination begins. This invagination is nothing else than the ingrowth of the ectoderm cells, which grow inwards from the margin of the envelope and form the continuous dorsal plate of cells which, as in the case of *Petromyzon*, represents the ectoblastogenous rudiment of the notochord and of the mesoderm. This invagination in no way assists in the formation of the enteric cavity. The intestine is formed by the divergence and displacement of the endoderm cells, which are not invaginated, but were previously situated here, and may be distinguished all the time from the smaller ectoderm cells by their relative size, by the amount of the yolk-granules which they contain, and to a certain extent by their want of pigment. While the dorsal invagination is taking place, the cavity which subsequently becomes that of the intestine is gradually formed by divergence of the endoderm cells. The formation of the wall of this cavity proceeds in precisely the same manner as in *Amphioxus* and *Petromyzon*, i. e. the endoderm cells separate in such a way that they first give rise to the ventral and lateral boundary of the intestine, while the dorsal portion is still open. Thus it comes to pass that the rudiment of the notochord, which has separated from the lateral mesodermal rudiments, temporarily takes part in the limitation of the enteric cavity. Subsequently the endoderm cells unite beneath the notochord, which in this manner is again excluded. As regards the lateral portions of the dorsal plate-like ingrowth, which represent the ectoblastogenous rudiment of the mesoderm, they are from the first excluded from the delimitation of the enteric cavity owing to the intervening endoderm cells, part of which attach themselves to the ectoblastogenous mesoderm cells in order to furnish their contribution to the formation of the mesoderm.

I must not conceal the fact that these conditions are not exhibited by all Amphibians. According to the statements of certain investigators the Anura are an example of an instance in which the notochord is excluded from the outset from the delimitation of the enteric cavity. Unfortunately I have no experience myself in this direction, since I have not studied the development of the Anura. But if this statement is correct, the Anura in this respect approach the Selachians and Teleosteans, as will be shown further on.

It is sufficiently clear from what has been stated that in the case of the Amphibia also a distinction must be drawn between the dorsal invagination and the formation of the intestine. They are two different processes, which have a certain relation one to another only because the formation in one organism of two neighbouring organs always shows certain points of contact or connexion. As regards the formation of the mesoderm, this arises from ectoderm as well as from endoderm, and moreover not only in the lateral mesodermal rudiments to which reference has already been made, but also in the so-called ventral mesoderm, in which also no sharp dividing line is to be drawn between the ectoblastogenous and endoblastogenous mesoderm cells. In this brief communication, however, devoid as it is of figures, I cannot enter more closely into these details, and must postpone an account of them until the publication of the longer paper which is to follow.

In passing on to the description of the corresponding developmental processes in the meroblastic ova of Selachians and Teleostean fishes, I must at the outset join issue with those embryologists who, following the example of Hæckel, would regard the yolk merely as a store-room from which the germ derives nutritive matter, and who would deny to the vitelline elements all participation in the formation of the embryo. Although this view must now be regarded as an anachronism, there are still some investigators even at the present time who assume that the yolk in Teleosteans and Selachians takes no share in segmentation. In contradiction to these embryologists I have to state that, according to the results at which I have arrived, the entire endoderm (the definitive intestine and the endoblastogenous mesoderm) in Teleostean fishes as well as in Selachians owes its origin to the vitelline elements.

I will commence the description of my investigations with the Teleostean fishes, which, owing to the fact that their ova contain less yolk, approach the Amphibians more closely in these processes than do the Selachians, in which the same developmental processes are more modified, probably in consequence of the larger quantity of yolk. In the case of all the Teleosteans studied by me (*Labrax*, *Julis*, and *Gobius*), no sharp boundary can be distinguished between the blastoderm cells and the yolk. The lower blastoderm cells are so intimately connected with the subjacent yolk that no dividing line is to be seen. These cells divide in an equatorial direction, and, moreover, in such a way that the uppermost cell which is thus produced becomes constricted off and joins the blastoderm cells, while the lower one, on the contrary, remains in connexion with the yolk. I have observed no trace of a segmentation cavity in any of the Teleosteans which I have investigated. After the blastoderm has been formed and the blastoderm cells commence to grow round the yolk we may observe upon the surface of the latter a continuous layer of protoplasm with nuclei, around which the outlines of cells are sometimes to be seen. This is the **intermediate layer** of authors, the nuclei of which, which are direct descendants of nuclei of the lower blastoderm cells, were termed merocytes or periblast nuclei. The presence of so many nuclei without the outlines of cells is probably to be explained as being due to rapid nuclear division without corresponding cell-division. I must lay stress on the fact that these nuclei do not perish, as some investigators would have us believe, but form new cells, which take part in the building-up of the embryo. I shall designate these nuclei simply as **yolk-nuclei.**

After the formation of the blastoderm a more or less distinct boundary may be noticed between the blastoderm and the yolk, or, more strictly speaking, between the blastoderm and the intermediate layer which belongs to the yolk. Yet we may observe all the time the equatorial division of the yolk-nuclei and the formation of new cells, which become constricted off from the yolk and join the blastoderm cells. Now, after the overgrowth of the yolk by the blastoderm cells has commenced it is time to distinguish the primary germinal layers. **I consider the entire blastoderm, the cells of which grow over the yolk, as the ectoderm, but the yolk with the yolk-nuclei must be termed the endoderm,** since the intestine arises from these vitelline elements.

In passing on to the description of the further developmental processes which usher in the formation of the notochord and the mesoderm it is necessary for me to draw attention to the fact that in none of the Teleosteans which I have examined have I observed an invagination. It is well known that certain investigators maintain that the mesoderm in Teleostean fishes is formed by invagination, while others, on the contrary, assert that it arises by cleavage of the blastoderm cells. Although I myself have not observed any invagination, I think I may assume that no essential difference exists between the two processes as they are described by different investigators; for the invagination in this case also has no connexion with the formation of the intestine, and is nothing else than the forward growth of the reflected edge of the blastoderm. In both cases therefore the same blastodermal or ectodermal elements are engaged, and it is a matter of secondary importance whether the cells are from the outset arranged in such a way that the continuous rudiment of the notochord and mesoderm arises by splitting off from the upper portion of the blastoderm (the rudiment of the nervous system), or whether this rudiment is formed by the forward displacement of the cells starting from the margin of the enveloping layer. Whether by means of the process of splitting-off or by that of so-called invagination, the continuous rudiment of the notochord and mesoderm is equally formed from the same elements (ectoderm cells) as those from which the nervous system is also developed. In this rudiment the central portion (the rudiment of the notochord) becomes differentiated from the lateral regions, from which the mesoderm arises. But here also it may be seen that the endoderm cells take part in the formation of the mesoderm, since the cells which arise from the yolk-nuclei become constricted off and join the rest of the mesoderm cells. Thus in the present case, as in that of other Vertebrates, we can distinguish a twofold source whence the mesoderm arises (ectoblastogenous and endoblastogenous). While the formation of the notochord and mesoderm is taking place there is formed upon the surface of the yolk from the yolk-nuclei the continuous layer of cells from which the intestine is developed. In this manner in Teleosteans also the intestine does not owe its origin to an invagination, but arises from the derivatives of yolk-nuclei.

While the cells of the blastoderm are growing round the yolk, the yolk-nuclei which are in process of multiplication commence to spread out over the latter, so that soon the entire periphery of the yolk is provided with these nuclei. I must emphatically controvert the view, which is held by many investigators, that these nuclei perish without taking part in the formation of the embryo. It has already been mentioned that the yolk-nuclei give rise to the intestine and participate in the formation of the lateral mesodermal rudiments; but I must add that the nuclei also which are situated in the lower (ventral) portion of the yolk take a share in the formation of the embryo, for in my preparations I notice mitoses in this region, and it may be observed that the cells which are here formed from the yolk-nuclei become constricted off and join the blastoderm cells which have grown round the yolk. I am inclined to assume that these cells are homologous with the ventral mesoderm of the Amphibians. In subsequent stages it may be seen that the yolk-nuclei take part in the formation of the liver, since a portion of the cells which arise from these nuclei is directly transformed into hepatic cells. The importance of the *rôle* of the yolk-nuclei cannot therefore be open to doubt.

I will now pass on to the Selachians.

Although at the present time Selachians are the favourite subject of embryologists, the latter are nevertheless not agreed as to many important developmental processes in these animals, and, above all, as to the origin of the intestine. While certain investigators regard the intestine as originating through invagination, the rest assert that it is formed from the yolk-nuclei. On the other hand, while in this manner an important *rôle* is ascribed to the yolk-nuclei by some investigators, the others deny that they take any share in the formation of the embryo. From my own results I am led to suppose that **not only the intestine, but also the entire endoderm, arises from the yolk-nuclei, while the blastoderm cells represent the ectoderm.** The formation of the intestine from the yolk-nuclei is so distinct in all stages that I cannot understand how this fact can be disputed. But, on the other hand, I must corroborate the assertion that a kind of invagination (blastodermal fold) is to be observed at the posterior margin of the germinal disk. My results consequently reconcile to a certain extent the statements of different investigators, for I confirm both the origin of the intestine from the yolk-nuclei, as also the presence of the invagination. But in the present instance also this invagination or doubling-down of the blastoderm cells has nothing to do with the formation of the intestine. I therefore see in it no process of gastrulation, but, as in the case of other Vertebrates, **the ingrowth of the ectoblastogenous rudiment of the notochord and mesoderm,** which proceeds in a forward direction from the posterior margin of the enveloping layer. The Selachians agree with the Teleostean fishes also in the fact that not only is the inversion of the blastoderm cells to be observed at the posterior margin of the enveloping layer, but also the splitting-off of cells here and there. These two different processes—the formation of the intestine from the yolk-nuclei and the ectoblastogenous invagination—are accomplished simultaneously in such a way that, while the ectoderm cells are invaginated at the posterior margin of the enveloping layer, the continuous sheet of endoderm is formed from the yolk-cells, which give rise to the intestine. The invaginating blastoderm cells in no way constitute the intestinal wall; they merely lie, while they grow inwards, so closely upon the true endoderm cells which have arisen from the yolk-nuclei, that the two different rudiments —the invaginated ectodermal one and the endodermal which has developed on the spot from the yolk-nuclei—are intimately connected one with another. It is the more difficult to draw a dividing line between the two rudiments, since in the lateral rudiments of the mesoderm both kinds of cells are in close connexion.

The rudiment of the notochord is excluded from the limitation of the intestinal cavity by the actual endoderm cells, and forms for a time an appendage of the dorsal wall of the intestine. As regards the mesoderm, we may follow Rückert in distinguishing the axial and peripheral portions of this layer.

In the formation of these parts of the mesoderm, which differ only in position, the cells of both ectoderm and endoderm participate. These two sources of the mesoderm cells are very distinctly visible; but the detailed demonstration must be reserved for my subsequent paper. I will here but briefly allude to one more point. It is evident from what has been stated that I by no means regard the Selachians as primitive forms, from which other animals are to be derived. I see no reason to derive the Amphibians from the Selachians, as is done by certain investigators. This amounts to deriving simple and primitive conditions from such as are complicated and modified. Although the Selachians in many respects exhibit primitive characteristics, their conditions are nevertheless so much modified in consequence of the superabundance of the food-yolk, that they can be regarded as the ancestral type of other animals just as little as the Teleostean fishes.

In the case of *Lacerta* no difficulty is experienced in distinguishing the two primary germinal layers, since we here get a bilaminate germinal disk as the result of segmentation. At the posterior margin of the germinal disk we may observe an active multiplication, and in consequence of this a proliferation of the ectoderm cells. This proliferating spot in the ectoderm, which in the case of Amniota is termed the primitive tubercle ("Primitivknopf"), primitive plate, primitive streak, and I know not what besides, gives rise to the ectoblastogenous rudiment of the notochord and mesoderm, which, starting from this point in a forward direction, grows in between the two primary germinal layers as a continuous plate of cells. In the middle of the primitive streak, but nearer its anterior end, there may be noticed a depression by which the invagination is ushered in. In this manner there arises the margin of the enveloping layer at which the cells of the rudiment of the nervous system and those of the rudiment of the notochord bend round into each other, and where numerous mitoses are to be seen. The direction of these mitoses shows in the clearest manner that the cells of the rudiment of the notochord grow forward from the margin of the overgrowth. This invagination in no way leads to the formation of the intestine, since all the invaginated cells are absorbed in the production of the notochord and mesoderm; but the intestine arises from the cells of the lower primary germinal layer. I have no reason in this case to designate the process of invagination as gastrulation, for this process here bears no relation to the formation of the intestine. It is true that certain investigators describe a sac-like invagination in the case of Reptiles, and consider its cavity to be that of the archenteron. But, in my opinion, this discovery does not prove what these authors wish to prove, but rather exactly the opposite, since it is evident from their description that, although the cavity produced by invagination exists, nevertheless its walls do not participate in the formation of the intestine, and that the cavity of invagination in no way becomes that of the intestine.

Consequently here also we see in the invagination a process characteristic of the Vertebrata, namely the formation of the ectoblastogenous rudiment of the notochord and mesoderm. In this case also the notochordal rudiment, after it has separated from the lateral rudiments of the mesoderm, enters into a temporary connexion with the endoderm cells, since it becomes intercalated among them; but subsequently the notochord is once more excluded. A correct description of this process has already been furnished by many investigators.

As regards the mesoderm, we can here distinguish the axial and peripheral regions of this layer. The axial mesoderm develops on both sides of the notochord from the ectoblastogenous rudiment already described; but the cells which split off from the endoderm also take part in the formation of these mesodermal rudiments. The peripheral mesoderm is formed from the endoderm cells. To the peripheral mesoderm likewise belongs that at the posterior margin of the primitive streak, which also arises from the cells of the endoderm.

The following important conclusions result from my investigations:—

(1) In the invagination in the case of *Amphioxus* two different processes are to be distinguished:—(*a*) The invagination of the endoderm cells which form the intestine (the palingenetic process or gastrulation); (*b*) the dorsal invagination of the ectoderm cells, which constitutes the ectoblastogenous rudiment of the notochord and mesoderm (the cenogenetic process).

(2) In all Vertebrates these two processes can be distinguished—the origin of the intestine from the endoderm cells, and the formation of the rudiment of the notochord and mesoderm from a proliferation of the cells of the ectoderm.

In no Vertebrate is the intestine formed by invagination. The endoderm cells are overgrown by those of the ectoderm, and the intestine arises through divergence of the former. In the process of overgrowth a modified gastrulation may be seen. But the further this process extends the more it is suppressed. In meroblastic ova, where the yolk is very large (Selachians, Sauropsida), the process of overgrowth is so greatly modified in consequence of adaptation to the new conditions that gastrulation is practically entirely suppressed. The dorsal ectodermal invagination, on the contrary, exists in all Vertebrates as a characteristic process, which has nothing to do with the formation of the intestine, and is to be regarded as a new formation *, that is, as the ingrowth of the ectoblastogenous rudiment of the notochord and mesoderm. This rudiment develops from the cells of the ectoderm and has a common origin with the rudiment of the nervous system.

(3) In no Vertebrate is a true gastrula to be observed; it is therefore impracticable to search for the gastrula mouth in its proper sense, and to endeavour to discover its dorsal and ventral lips, since the primitive conditions are practically entirely obliterated by the new formations. Accordingly I leave this question out of consideration. I consider all attempts to homologize the dorsal and ventral lips of the gastrula mouth in different Vertebrates as forced and unnatural.

(4) There is only one spot in the germ the homology of which can be traced in all Vertebrates, namely that from which the invagination † of the ectoderm cells proceeds—in other words, where the ingrowth of the ectoblastogenous rudiment of the notochord and mesoderm commences.

(5) The so-called neurenteric canal appears to me in a very different light. It is not a tube of communication between the nervous system and the intestinal tract. Just as the margin of the enveloping layer represents a transitional region between the cells of the rudiment of the nervous system and the rudiment of the notochord, so this canal is to be regarded as the morphological expression of this transition. Therefore it may be regarded as a canal of communication between the tube of the nervous system and the notochordal groove or notochordal cavity, and may be termed the *neurochordal*

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* It will be evident from this that I virtually dissent from the customary view, according to which the posterior end of the germ, where the invagination is to be observed, exhibits more primitive conditions.

† In the majority of cases it is really not a true invagination, but merely the ingrowth of the cells or the turning-in of the margin of the enveloping layer.

canal. This canal owes its origin to the genetic connexion between the rudiment of the nervous system and that of the notochord.

(6) The fact that the rudiment of the notochord and of the mesoderm arises as a continuous mass of cells from a rudiment which also gives origin to the nervous system may be turned to account for the purposes of phylogeny. It follows from this that, in attempting to derive the bilaterally symmetrical Chordata from Cœlenterate-like forms with radial symmetry, we must remember that the notochord and the mesoderm situated on either side of it in no way arise from the dorsal portion of the intestine, but from the ingrowth of the proliferating ectoderm cells. Since this ectoblastogenous mesoderm is chiefly utilized for the formation of the musculature, we may apply the term *chordo-muscular* to the entire ectoblastogenous rudiment. Since this rudiment has a common origin with that of the nervous system, the Chordata exhibit a direct connexion with the Annelids, in which, according to the investigations of Kleinenberg, the musculature also arises from the common neuro-muscular rudiment. In my opinion the resemblance is still further increased by the presence of the cephalic shield (or ventral shield, as the case may be) in Annelids, which, in its position and its relation to the nervous system and the muscles and in its structure, is very similar to the notochord. It might then be assumed that this continuous neurochordo-muscular rudiment had already made its appearance in the animals which are to be regarded as the common ancestors of the Chordata and the Annelids. The notochord may have arisen in these forms from an ectodermal rudiment as an axial structure which served for the attachment of the musculature on the one side and of the nervous system on the other. The further development and differentiation of different portions of this continuous ectodermal rudiment might have taken different roads. In the Annelids the notochordal rudiment experienced no further development. Perhaps, nevertheless, in the case of certain Annelids a homologue of the notochord may be proved to exist in the epithelial vesicular tissue *, which, in addition to a certain similarity of structure, also exhibits some resemblance to the notochord in the fact that it serves for the attachment both of the nervous system and of the lateral musculature.

The Ascidians have followed another path. In these

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* I shall later on make a special communication on the subject of this notochord-like structure in Annelids.

animals the notochord is only found in the tail. We might imagine such an animal as an Ascidian larva to have been developed in the following manner :—The proliferation arising at the posterior end by multiplication of the cells, which represents the chordo-muscular rudiment, instead of growing forwards between the intestine and external covering, as in Vertebrates, formed an appendage in which the notochord and the lateral musculature were differentiated from the common rudiment. It must be pointed out that the lateral muscles are present only on either side of the notochord, *i. e.* only in the tail of the larva; in the body of the Ascidian, where there is no notochord, they are entirely absent. This shows with sufficient clearness that the lateral musculature and the notochord here by no means arise from the elements of the endoderm (dorsal portion of the intestine) as is commonly supposed, but, as I think, from a special continuous ectodermal rudiment. In *Amphioxus* and the Vertebrates the proliferation of the ectoderm cells proceeds from the hinder margin in such a way that the chordo-muscular rudiment grows forward between the two primary germinal layers, and thus forms a plate of cells which is situated between the nervous system and the intestine. The ingrowth of this rudiment from the posterior margin of the enveloping layer may be regarded as an ancestral feature, since in the case of the Ascidians also the proliferation takes place at the posterior margin. But this process was subsequently capable of being so far modified that in certain Vertebrates, in addition to growth from the margin of the enveloping layer, splitting-off of the ectoderm cells is also observable. From this point of view the dorsal wall of the gastrula of *Amphioxus*, the dorsal wall of the corresponding stages in *Petromyzon* and the Amphibia, the blastoderm of the Selachians and Teleostean fishes, and the ectodermal portion of the germinal disk with the primitive streak and cephalic process of the Amniota, each represent a continuous rudiment, from which the nervous system, the notochord, and the lateral musculature are developed.

(7) The fact that the notochord, although it arises from an ectoblastogenous rudiment, nevertheless enters into a transient connexion with the cells of the endoderm, may also be turned to account for the purposes of phylogeny. It points to the conclusion that the notochord soon after its origin entered into intimate relations with the intestine, and perhaps also commenced to serve for its attachment. This connexion, however, is to be regarded as being of a secondary nature.

I desire to set up this conception in opposition to the theory of gastrulation which at present prevails. I would mention once more that I reserve for my subsequent paper the full description of my investigations and the detailed statement of proof, as well as the consideration of the literature of the subject. In the present communication I wished to substantiate my view as shortly as possible.

Moscow, Nov. 1892.

LXI.—*Descriptions of some new Longicorn Coleoptera from the Indian Region.* By C. J. GAHAN, M.A., of the British Museum (Nat. Hist.).

[Plate XIX. figs. 4–7.]

THE new species described in this paper form part of some recent accessions to the British-Museum collection. Those from the collections made by Mr. G. Q. Corbett in Burma and by Mr. A. Bell in South India were presented through the intermediation of Dr. Andrewes; while most of the remaining species described are from the collections made by the late Mr. E. T. Atkinson.

Æolesthes basicornis, sp. n.

Aureo-sericeo pubescens; prothorace lateraliter in medio subangulato et leviter tuberculato; dorso transversim undulateque rugoso, versus medium sulcis duabus antice conjunctis longitudinaliter impresso; elytrorum apicibus anguste truncatis, utrisque bidentatis; antennis quam corpore triplo longioribus, articulis 1° 3°que transversim rugulosis, hoc apice subabrupte crassato.

Long. 38, lat. 10·5 mm.

Hab. Andaman Islands (*Atkinson Collection*).

The underside of the head is crossed by a deep intergenal groove, which is followed by a second shallower and somewhat ill-defined groove; both grooves are slightly bowed forwards in the middle. The prothorax is somewhat constricted anteriorly; it is obtusely angulate and provided with a very small tubercle at the middle of each side; it is wrinkled above over almost the whole surface, the rugæ having a wavy course in a general transverse direction; two longitudinal impressions, bending towards the middle line to unite anteriorly, cut off a central space which is wrinkled like the rest of the surface. The silky pubescence of the elytra is so arranged as to present the appearance of numerous brighter and less bright areas varying in lustre with the direction in which the light falls upon them. The antennæ of the male are about three times as long as the body; the first joint and the third are transversely rugulose, the third joint has at the apex an abrupt ring-like thickening which projects rather more on the outer side; the fourth and fifth joints are also slightly thickened at the apex; each of the joints from the fifth to the eighth is furnished with a small acute spine at the outer apex, and each from the sixth to the tenth is denticulately produced at the inner apex; the third joint is slightly longer, the fourth a little shorter, than the first; the fifth is distinctly longer than the third.

Margites sulcicollis, sp. n.

Niger, griseo sparse setosus; elytris piceo-brunneis, griseo tenuiter pubescentibus et fulvo sat dense setosis; prothorace basi apiceque constricto, lateraliter rotundato, dorso utrinque quadrisulcato, medio sparsim punctato; corpore subtus pedibus antennisque piceis vel nigris, griseo tenuiter pubescentibus; antennis (♀) quam corpore brevioribus, articulis 1°, 3°, 5°que subæqualibus, utrisque quam quarto paullo longioribus, articulis 6° et sequentibus gradatim crescentibus.

Long. 13 mm.

Hab. Paungdé, in Burma (*G. Q. Corbett*).

Prothorax strongly enough rounded at the sides in the middle, narrowed at the base and apex; the disk with two very distinct longitudinal grooves which cut off a median, somewhat oblong, and sparsely punctured area from two lateral plagæ, each of which is traversed longitudinally by three or four narrower and less distinct grooves, the intervals between which are narrow and cariniform, the sides below these areas are intricately and not strongly rugose. The elytra bear punctures of two kinds—larger and less closely crowded punctures from which the suberect fulvous setæ spring, and minute closely crowded punctures occupying the intervals and giving rise to the finer hairs of the laid pubescence.

This species is to be recognized by the peculiar sculpturing of the prothorax.

Nyphasia apicalis, sp. n.

Fulvescens; elytris apice chalybeato-violaceis, utrisque ad suturam breviter spinosis; antennis (♂) quam corpore sesqui-longioribus, articulis 3° ad 6^{um} nigris, apice extus spinosis, articulo 7° brevius spinoso, hoc et sequentibus testaceo-fuscis; corpore subtus pedibusque rufo-fulvescentibus.

Long. 15 mm.

Hab. Canara, in South India (*A. Bell*).

This species agrees closely in structural characters with *N. Pascoei*, Lac., and *N. fuscipennis*, Gah., but has the prothorax somewhat more strongly tuberculate at the middle of each side, the scutellum more prolonged behind, and the elytra each furnished with a short sutural spine at the apex. It may be further distinguished by its coloration, being entirely of a somewhat reddish fulvous, with the exception of a small portion at the apex of the elytra which is violet-blue, and of the antennæ, of which the two proximal joints only are fulvous.

Although this species has the elytra spined at the apices, it accords in other respects much better with Lacordaire's second section of the genus, the remaining species of which have the elytra unarmed at the apex.

Cleonice bivittata, sp. n.

Viridis, pedibus antennisque atro-cæruleis; elytris creberrime punctatis, viridi-opacis, vitta dorsali utrinque æneo-viridi, apice conjunctim subacuminate rotundatis; antennis (♂) quam corpore multo longioribus; articulo tertio quam quarto sequi-longiore, articulis primo tertioque sulcatis.

Long. 19, lat. 4·75 mm.

Hab. Baram, in North-west Borneo (*Everett*).

Head rather sparsely punctured in front, more densely above and on the sides; impressed along the middle in front with a linear groove which extends backwards above, between the antennæ and eyes, as far as the middle of a small sparsely-punctured dorsal area. Prothorax thickly punctured above, except along the anterior margin, on a small centro-dorsal area, and over each of two feebly raised and obtuse tubercles which are placed towards each side. Elytra very closely punctured, of a rather dark dull green colour, but each with a dorsal vitta of a somewhat brassy and brighter colour. The body underneath is also green, but is clothed with a faint silvery-grey pubescence. The legs and antennæ are dark blue, the peduncles of the femora only being greenish. The antennæ of the male are more than half as long again as the body; the first and third joints only are sulcate along their anterior or inner surface; the third is about half as long again as the fourth.

The colour and punctuation of the elytra in this species are very suggestive of the South-African genus *Ochimus.* I am not quite certain that the species is congeneric with *Cleonice vestita*, Thoms. (=*Seuthes sericatus*, Pasc.), as I have no example of the latter by me with which to compare it.

Epepeotes andamanicus, sp. n.

Niger, griseo tenuissime pubescens; prothorace transverso, lateraliter utrinque spinoso, dorso medio leviter transversim rugosulo; elytris punctatis, punctis versus basin asperatis, apicibus sinuato-truncatis.

Long. 25 mm.

Hab. Andaman Islands (*Prof. Meldola* and *Atkinson Coll.*).

Black, with a faint slate-grey pubescence. Head and prothorax almost impunctate; the latter feebly wrinkled over the middle of the disk, armed with a sharp tubercle or spine on the middle of each side. Elytra densely punctured, the punctures being more closely crowded and asperate on the basal portion, and becoming gradually smaller towards the apex.

This species has some resemblance to *Paragnoma nigra*, Thoms., with which it was confounded in the collection of the late Mr. E. Atkinson, but may be distinguished by the shorter and more transverse prothorax and the lateral spines with which it is armed.

Epepeotes uncinatus, Gahan.

A variety of this species, represented by a single female specimen taken by Mr. Alexander Bell at Canara in South India, differs from the described form in having the black spots of the elytra much more elongated; those along each side of the suture especially, forming for some distance an almost continuous vitta. This variety has a remarkable resemblance to *Macrochenus tigrinus*, Oliv., which occurs also in South India as well as in Ceylon. An analogous case of resemblance is furnished by *Macrochenus birmanus*, Thoms., and *Epepeotes guttatus*, Guér.

Macrochenus Atkinsoni, sp. n.

Niger; capitis fronte, lateribus vittaque dorsali, vittis tribus prothoracis (una dorsali, una utrinque laterali), scutello et maculis irregularibus elytrorum fulvo-pubescentibus; corpore subtus nigro, vitta utrinque abdominis et maculis thoracis fulvo-pubescentibus; apicibus elytrorum sinuato-truncatis. (♂) Prothorace

quam latiori sesqui-longiori. (♀) Prothorace quam latiori vix longiori.
Long. (♂) 23, (♀) 29 mm.

Hab. Andaman Islands (*Atkinson Collection*).

Black, covered with a faint dark grey or brownish indumentum. Sides and front of the head and a dorsal median vitta fulvous. Prothorax with three fulvous vittæ, one medio-dorsal, and one, low down, on each side; transversely wrinkled above and rather sparsely punctured. Elytra rather strongly punctured at the base and for a short distance behind each shoulder, more feebly and sparsely punctured over the rest of their surface, especially towards the apex; adorned with a somewhat variable number of spots of fulvous pubescence which are of different sizes and very irregular in shape. The apices of the elytra are sinuately truncate, with the outer angles very feebly denticulate.

This species agrees in its general structure with *M. Guerini*, White, but may be easily distinguished by its different style of marking.

Thestus armatus, sp. n.

Pube fulvo-ferruginea obtectus; prothorace lateraliter in medio valde spinoso; elytris basi minute sat denseque granulatis, fasciis duabus cinereis transversim arcuatis ornatis; antennis (♂) quam corpore duplo longioribus.
Long. 35, lat. 11·5 mm.

Hab. Sandakan, in North-west Borneo (*Atkinson Collection*).

This species seems to have the closest resemblance in colour and pattern of marking to *Thestus oncideroides*, Pasc. The granules on the basal portion of the elytra are closer together than they are represented to be in the figure of the latter species. The present species differs chiefly, however, in having a strong spine on each side of the prothorax. In *T. oncideroides* the prothorax has but a feeble tubercle or tooth on the middle of each side.

Eutænia Corbetti, sp. n.

Nigra; capitis fronte lateribusque, fasciis duabus prothoracis medio interruptis, scutello et maculis vittisque elytrorum, fulvescente-pubescentibus; corpore subtus pedibusque plus minusve fulvescentibus; antennis (♂) quam corpore multo longioribus, nigris, articulo primo crasso, apice late cicatricoso, articulis 3° ad 5^{um} subæqualibus, utrisque quam primo sesqui-longioribus, articulis 6° 7°que paullo decrescentibus (ceteri desunt).
Long. 18 mm.

Hab. Tharawaddy, in Burma (*G. Q. Corbett*).

Deep black; with the front and sides of the head, two transverse bands of the prothorax, one anteriorly, the other at the base, both broadly interrupted in the middle, the scutellum, six spots and two posterior vittæ on each elytron, covered with a dense yellowish-tawny pubescence. Of the six spots on each elytron three form a transverse row a little behind the base, the innermost spot being much smaller than either of the two exterior; two spots are placed obliquely near the middle, with the inner spot farther back than the outer; the remaining spot is small and triangular and is placed close to the suture in a line with, and a little farther back than, the innermost spot of the anterior row. The two posterior vittæ, of which that nearest the suture is shorter and broader, narrow behind and unite at the apical border. The black portions of the prothorax and elytra, which are made opaque by a black powdery or scaly pubescence, are seen to be rather thickly and strongly punctured. The body underneath and parts of the legs are clothed with a less dense pale fulvous pubescence.

The spots and vittæ of this species will probably be found to vary. The entirely black antennæ, together with the style of marking, distinguish it at once from other species of the genus.

POLYTRETUS, gen. nov.

Head with the front rectangular, slightly higher than its breadth, with the antennal tubercles rather prominent, slightly divergent, and at their base approximate, so that the concavity between them is deep and rather narrow. Eyes moderately large, their upper lobes narrow, their lower lobes extending downwards more than halfway to the base of the mandibles. Antennæ about half as long again as the body, with the scape moderately elongate and gradually and not strongly thickened to the apex, where it is provided with a narrow and completely margined cicatrice; third joint about half as long again as the scape; the fourth and following joints gradually diminishing in length; the distal halves of the third and fourth joints thickly fringed with hairs on the outer side. Prothorax slightly transverse, furnished at the middle of each side with a rather short conical tubercle which points somewhat obliquely upwards. Elytra rather elongate, with the sides subparallel and the apices rounded. At the base, between the scutellum and the shoulder, each elytron presents a small angular lobe which projects forwards and slightly overlaps the base of the prothorax. Legs subequal to one another in length. Intermediate tibiæ with their outer margin entire. Claws of the tarsi broadly divergent, but not strictly divaricate. Prosternal process almost horizontal, being but feebly raised towards the middle of its length; it is very slightly widened posteriorly and just at its hind extremity bears on each side a very small process which does not reach to the free end of the epimeron; so that the anterior acetabula remain slightly open behind. The mesosternum is gradually narrowed posteriorly, and bears a small but distinct tubercle.

This genus must, in accordance with the system of Lacordaire, be placed in the group of the Monohammides, from all the other members of which it may be very readily distinguished.

Polytretus cribripennis, sp. n. (Pl. XIX. fig. 4.)

Piceo-niger; antennis articulis tertio quartoque nigro-fimbriatis; prothorace nitido fere impunctato, disco inæquali, postice tuberculo medio paullo elevato et supra planato munito; elytris fulvo-testaceis, crebre foveato-punctatis, utrisque lineis tribus—duabus dorsalibus, tertia laterali—paullo elevatis.

Long. 11·5, lat. 3·5 mm.

Hab. Mungphu, in Sikkim (*Atkinson Collection*).

Head, prothorax, body underneath, legs, and antennæ black, with a slightly reddish tint at the margins of the prothorax and of the abdominal segments. The antennæ are dull in colour, being covered with a faint blackish pubescence; the third and fourth joints are thickly fringed with blackish hairs on their outer and lower border throughout the greater part of their length. The disk of the prothorax has on each side, in front of the middle, a small convex polished area, which is separated from its fellow by a median slightly depressed area; between the middle and the base there is a median slightly raised area which is flattened and not very smooth above, and which has a rounded and sharply-limited posterior border. The elytra are very strongly and closely punctured throughout, and are entirely of a fulvous-testaceous colour; they are rounded at the apex, and each bears three slightly, and not very distinctly, raised lines—two dorsally and one towards the side.

Anamera fulvescens, sp. n.

Fusca, supra pube fulvescente sat dense obtecta; elytris dense punctatis, viridi-fuscis, fulvo-pubescentibus; corpore subtus fulvo-cinereo-pubescente.

Long. 23, lat. 8·5 mm.

Hab. South India (*Atkinson Collection*).

Head and prothorax very sparsely punctured, covered with a rather close fulvous pubescence; their derm, where exposed by the rubbing away of the pubescence, is seen to have a dark brown colour. The elytra are closely punctured, and are clothed with a pale fulvous pubescence. The underside of the body is paler than the upperside, being covered with an ashy fulvous pubescence. The first joint of the antennæ is dark brown with a grey pubescence, the third and following joints are testaceous with a pale grey pubescence.

Two species only have hitherto been placed in the genus *Anamera*, viz. *A. alboguttata*, Thoms., and *A. concolor*, Lacord. (Gén. des Coléop. ix. p. 383. 1), in both of which the labrum is arcuately emarginate and the upperside of the thorax and elytra furnished with rather long, erect, black hairs—characters not found in the present species. But when this species is compared in its general structure with *A. concolor* there seems little reason to doubt that the two are congeneric. The genus *Anamera* was placed by Lacordaire in the group of the Mesosides; but why in this group, rather than in the Monohammides, I fail to understand: the cicatrice of the antennal scape is completely margined, the lateral spines of the prothorax are median in position, the intermediate tibiæ grooved, and the claws of the tarsi divaricate.

PARAGNIA, gen. nov.

Head with the front widening towards the base, with the antennal tubercles prominent, slightly diverging and separated from one another by a rather narrow wedge-shaped interval above. Eyes emarginate, with their lower lobes rather small. Antennæ a little longer than the body; with the scape thickened, slightly curved, and furnished at the apex with a cicatrice the limiting carina of which is incomplete; third joint about half as long again as the scape, distinctly thickened throughout nearly the whole of its length; fourth a little shorter than the third, the fifth and following gradually decreasing in length. Prothorax slightly transverse, somewhat narrowed towards the base; its sides unarmed. Elytra rounded at the apex. Legs subequal to one another in length. Intermediate tibiæ with a distinct oblique groove just below their middle. Claws divaricate. Prosternal process rather feebly arched and narrow between the coxæ, gradually dilated behind up to its posterior border. Mesosternal process narrowing posteriorly, bearing a feeble tubercle between the coxæ.

The shape of the head seems to determine the position of this genus in the group of the Agniides. The absence of spines or tubercles from the sides of the prothorax and the incomplete margin to the cicatrice of the antennal scape are two characters which will distinguish the genus from the other members of the group, and which at the same time seem to point to an affinity with the Mesosides.

Paragnia fulvomaculata, sp. n. (Pl. XIX. fig. 5.)

Ferrugineus; capite fronte crebre minuteque punctulato, lateraliter et supra minus dense punctato; prothorace sat sparse punctato et dense minuteque rugosulo; elytris a basi ad medium grosse crebreque punctatis, subrugosis, pone medium minus fortiter sat denseque punctatis, utrisque maculis 12–14 fulvo-auratis; antennis quam corpore longioribus, articulis 4°–11^{um} apice infuscatis, basi grisescentibus.

Long. 14, lat. 5 mm.

Hab. Mungphu, in Sikkim (*Atkinson*).

Ferruginous red. Head minutely and very closely punctured in front, more sparingly and strongly punctured on the sides and vertex. Prothorax rather thickly punctured, and with numerous short and minute ridges which have a general transverse direction. Elytra with very large and closely placed punctures occupying almost the whole of the basal half; behind the middle, and for a short distance along the suture in front of the middle, the punctures are much smaller and less dense, while towards the apex they become still smaller and sparser; each elytron has about twelve or fourteen irregularly arranged spots of golden-tawny pubescence, nearly half of these spots being very small and punctiform. The underside of the body is coloured like the upperside, but the sides of the meso- and metathorax are somewhat blackish.

EUSEBOIDES, gen. nov.

Elongate. Head with the front slightly transverse and somewhat widened towards the base. Eyes emarginate, their lower lobes rather small. Antennæ about half as long again as the body; first joint subcylindrical, reaching to a little beyond the middle of the prothorax; third joint about equal in length to the first, the fourth a little longer; the fifth and following joints gradually decreasing in length. Prothorax cylindrical, parallel-sided, its length scarcely appreciably greater than its breadth. Elytra elongate, gradually narrowing from the base backwards; their apices narrowly truncate near the suture and prolonged at the outer angles into a rather strong spine; each elytron with a slightly raised and obtuse dorsal carina which runs at a short distance from the suture, and is separated from it by a shallow channel-like depression. Intermediate tibiæ with an oblique groove just below the middle of their length. Prosternal process feebly arched in the middle and rather widely dilated behind. Mesosternum with its intercoxal process rather narrow and almost parallel-sided.

This genus is allied to *Nyctimene*, Thoms., but may be distinguished by its shorter prothorax, the shorter scape of its antennæ, and the relatively longer fourth joint. Its legs also are longer, the hind femora being almost equal in length to the two first abdominal segments, while in *Nyctimene* they are not longer than the first segment.

Euseboides plagiatus, sp. n. (Pl. XIX. fig. 6.)

Fuscus, fulvo-brunneo haud dense pubescens; elytris utrisque plagis tribus pallidioribus—una prope basin, secunda vix pone medium nonnihil albescente, tertia prope apicem quoque albescente.
Long. 16–18 mm.

Hab. Mungphu, in Sikkim (*Atkinson Collection*).

Dark brown, with a not very dense fulvous-brown pubescence. Head thickly punctured. Prothorax somewhat more strongly punctured. Elytra rather thickly punctured, each with three rather ill-defined and somewhat broken patches of paler pubescence separated from one another by two areas covered with dark brown pubescence. The first paler patch, somewhat fulvous in colour, is near the base; the second, of a dirty white colour, is just behind the middle; the third, similar in colour to the second, is near the apex. Breast rather strongly and sparsely, the abdomen more feebly, punctured, each of the punctures being marked in position by a minute rounded dark brown spot.

Enispia bella, sp. n. (Pl. XIX. fig. 7.)

♀. Capite fusco, crebre punctato; antennis 12-articulatis, ferrugineo-fuscis, griseo pubescentibus et sat longe ciliatis, basi dense punctatis, articulo quarto testaceo, albido pubescente et ciliato; prothorace dense cinereo-hirsuto; elytris fuscis, basi et vitta longitudinali, leviter arcuata, rufo-brunnescentibus, griseo pubescentibus et setosis, fascia transversa paullo pone basin et fasciis duabus leviter arcuatis paullo ante apicem albidis; corpore subtus pedibusque testaceis, cinereo tenuiter pubescentibus, his longe

setosis; lateribus metathoracis et femoribus quatuor anticis paullo infuscatis.
Long. 8·5 mm.

Hab. Burma (*G. Q. Corbett*).

Head dark reddish brown, very closely punctured and with a thin greyish pubescence. Antennæ longer than the body, twelve-jointed, with the first joint about equal in length to the third and distinctly longer than the fourth, with the joints from the fifth to the eleventh subequal or very slightly diminishing in length, each shorter than the fourth; the twelfth joint distinctly shorter than the eleventh; the fourth joint with its proximal half testaceous and clothed with a whitish pubescence. Prothorax slightly constricted near the base and still more slightly near the apex, clothed with a dense yellowish-cinereous pubescence, which is raised in the form of two small tufts on the middle of the disk; the sides and two small patches near the base are less densely pubescent, are darker in colour, and are seen to be rather thickly punctured. The elytra are mostly of a dark brown colour, with the base, a dorsal (slightly arcuate) vitta on each side, and a narrow lateral border reddish brown; they are rather strongly and thickly punctured on the basal two thirds, with the punctures arranged, some irregularly, others in tolerably definite rows, one of which accompanies the dorsal reddish-brown vitta; the pubescence is mostly greyish in colour, but forms three narrow white bands—one transverse and slightly zigzag, forming a border behind to the basal reddish-brown portion, two posteriorly, which, as they approach the suture, separate from one another and again converge, so as to enclose a somewhat rounded space with a dark spot in its centre.

Eunidia lateralis, sp. n.

Supra pube fulvescente dense vestita, vitta lata utrinque a capite ad apicem elytrorum extensa nigro-fusca; corpore subtus pedibusque cinereo tenuiter pubescentibus; antennis nigro-fuscis.
Long. 6·5 mm.

Hab. Canara, in South India (*A. Bell*).

This species resembles *Eunidia simplex*, Gahan, but may be readily distinguished by the rather broad and distinct dark brown vitta which runs along each side from the head to the apex of the elytra: this vitta has a nearly straight upper margin; it is narrowed posteriorly in correspondence with the narrowing of the elytra towards the apex, and it ends at the angle formed by the slightly curved postero-external margin of the elytron with the oblique inner or apical margin. The body underneath and the legs are black, with a faint ashy-grey pubescence. The front of the head is grey in its lower portion, fulvous towards the vertex. The antennæ are almost black and are about half as long again as the body.

Glenea Andrewesi, sp. n.

Testacea, pube griseo-cervina sat dense vestita; capite medio nigro-lineato; prothorace vittis sex interruptis aut maculis duodecim nigris ornato; elytris utrisque maculis duabus—una basali, altera paullo pone medium—et postice vittis tribus angustis, nigro-fuscis; apicibus truncatis, extus brevissime dentatis.

Long. (♂) 11, (♀) 15–16·5 mm.

Hab. Canara, in South India (*A. Bell*).

This species is allied to and rather closely resembles *G. spilota*, Thoms., but may be distinguished by the different position and arrangement of the dark markings on the elytra. One rounded black spot is just behind the humeral depression at the base of each elytron; a second rounded black spot is placed nearer the suture just behind the middle of the elytron, and from near its outer border two narrow dark brown vittæ proceed backwards for a short distance, while a third brownish vitta arises a little behind its inner border and runs close alongside the suture to within a very short distance of the apex. The apices of the elytra are very briefly and scarcely perceptibly toothed at the outer angles.

Glenea Belli, sp. n.

Nigra, dense punctata, vittis maculisque argenteo-viridi-squamosis; elytris lateraliter utrinque unicarinatis, apicibus oblique truncatis angulis dentatis.

Long. 9·5 mm.

Hab. Canara, in South India (*A. Bell*).

Head rather thickly punctured, black, with the sides and two longitudinal bands in front, united across the base, silvery green. Prothorax more thickly punctured, with a median longitudinal silvery-green band and with some band-like spots of a similar colour on each side. Scutellum silvery green. Elytra with a distinct carina on each side separating the vertical lateral portion of the elytron from the slightly convex or nearly horizontal disk. The vertical lateral portion bears two rows of punctures divided by a slightly raised line; the disk is closely and irregularly punctured, with the punctures becoming sparser posteriorly and disappearing near the apex. Each elytron has six silvery-grey spots, of which two are in the same transverse line at a short distance behind the base, the third is just in front of the middle and is placed transversely, with its inner extremity rather close to the suture; the fourth and fifth are smaller and more remote from the suture, the fourth just behind the middle, the fifth about midway between this and the apex; the sixth is at the apex, and from its inner edge a narrow sutural vitta passes forwards for about half the length of the elytron. The body underneath and legs are greyish, with the anterior portion of each of the metathoracic episterna, an anterior band on each of the first four abdominal segments, and the whole of the fifth segment so faintly pubescent as to appear black and subnitid.

EXPLANATION OF PLATE XIX. Figs. 4–7.

Fig. 4. *Polytretus cribripennis* (♂).
Fig. 5. *Paragnia fulvomaculata.*
Fig. 6. *Euseboides plagiatus.*
Fig. 7. *Enispia bella.*

LXII.—*On some allied* Pentatomidæ, *with Synonymical Notes.* By W. L. Distant.

Dalpada mirabilis, sp. n.

Olivaceous green; a central elongate spot at base of head, lateral margins, a central fascia (not extending beyond centre), and a narrow transverse fascia on anterior area of pronotum, five small basal spots and an obscure posterior central fascia to scutellum, lateral margins, apex, and the whole inner area of corium castaneous. Membrane very dark castaneous, its apex paler. Body beneath and legs ochraceous; lateral margins of head, sternum, and abdomen somewhat broadly olivaceous green; sternum with transverse spots of the same colour and with two large black spots between the anterior and intermediate coxæ. Intermediate and posterior femora spotted with castaneous, posterior tibiæ with the base and apex castaneous. *Anterior legs, intermediate tibiæ, and the antennæ mutilated.* Abdomen beneath with a central black spot on the penultimate segment. Lateral angles of the pronotum moderately prominent and nodulose; lateral lobes of the head slightly longer than the central lobe.

Long. 25 millim.; exp. pronot. angl. 13 millim.
Hab. India, Naga Hills.

I have for some years possessed a single mutilated specimen of this extremely fine species, and hoped to have procured a more perfect example. As I have not succeeded in doing so, I now describe *sans* antennæ and anterior legs. It cannot be mistaken, and there is no other species of the genus which resembles it either in size or colour.

Dalpada insularis, sp. n.

Ochraceous or reddish ochraceous, coarsely punctured with greenish black. Head with the punctures thickest on the lateral lobes and on the margins of the central lobe; antennæ pale castaneous, bases of the fourth and fifth joints broadly ochraceous. Pronotum with the lateral margins strongly serrate, the lateral angles, which are moderately prominent and robust, black, with their apices ochraceous. Scutellum with three obscure and ill-defined pale basal spots. Head and corium more finely punctate than the pronotum and scutellum. Membrane cupreous. Connexivum reddish ochraceous, greenish black at the incisures. Body beneath and legs reddish ochraceous; head and sternum ornamented with fasciæ of greenish-black punctures. Abdomen with a broad submarginal fascia of green punctures. Anterior tibiæ dilated, with their apical halves sometimes darker in hue.

Long. 15–19 millim.; exp. pronot. angl. 8½–10 millim.
Hab. Malayan Archipelago: Ombay, Putar.

Coctoteris exiguus, sp. n.

Ochraceous. Head coarsely punctate; antennæ with the first and second joints ochraceous, outwardly margined with black, third, fourth, and fifth joints black, the base of the third joint brownish; pronotum (excluding the anterior area) with exceedingly coarse black punctures, and with two central black spots on anterior margin; scutellum with the anterior half with exceedingly coarse black punctures, the central basal area impunctate, posterior half more finely and sparsely punctate; an elongate black fovea at each basal angle; corium somewhat thickly and finely punctate; membrane pale fuscous with the margins paler, or uniformly brownish ochraceous with the veins darker. Body beneath and legs ochraceous; lateral areas of the head and sternum coarsely but sparingly punctured with black; two small black spots on the lateral areas of the pro-, meso-, and metasternum. Abdominal spiracles black.

The central lobe of the head is very little longer than the lateral lobes; the pronotal angles are moderately and subacutely produced; the lateral pronotal margins are somewhat obscurely denticulated; the posterior angles of the sixth abdominal segment are only moderately produced.

Long. 13 millim.; exp. pronot. angl. 7½ millim.

Hab. New Guinea (*Goldie*); Duke of York Island.

This species is rather aberrant in its generic characters, but the position of the ocelli alone will show that it is a *Coctoteris* and not a *Spudæus*.

Halys neelgiriensis, sp. n.

Ochraceous, thickly punctured with brassy black; head, anterior area and lateral angles of pronotum metallic green; antennæ black, the joints very narrowly ochraceous at base, fourth joint annulated with ochraceous near base (fifth joint mutilated). Head with a spot at apex, an oblique spot on each side near eyes, and a reversely directed oblique spot on each side near base ochraceous; eyes castaneous, with their inner margins ochraceous; ocelli red. Pronotum with the anterior and lateral margins ochraceous, and with a dull ochraceous spot on the green lateral angles. Scutellum with five small ochraceous spots at base and the apex ochraceous. Connexivum ochraceous, broadly greenish black at the incisures. Body beneath and legs ochraceous, lateral margins of head and sternum broadly metallic green; femora and sublateral areas of abdomen darkly punctate. Abdomen with small marginal spots at incisures and a spot on the three ultimate segments of the abdomen; tibiæ with outer spots at base, centre, and apex, and the apices of the tarsi black.

Long. 20 millim.

Hab. India, Neelgiri Hills (*Hampson*).

This second Indian species of *Halys* is distinguished from *H. dentata*, Fabr., not only by the colour differences, but by the head being much broader, especially at the apex, and its lateral margins more strongly toothed; the lateral margins of the pronotum more finely crenulate; the apical third of the scutellum much more elongate and narrow; second joint of the antennæ much shorter than the third, &c.

NEVISANUS, gen. nov.

Head about as long as central portion of the pronotum, broad, the lateral margins moderately concavely sinuate, but not toothed, the anterior margin truncate, the central and lateral lobes equally long. Antennæ a little more than half the length of the body, five-jointed, inserted about halfway between the eyes and apex; the second and third joints rather longly pilose, the basal joint reaching the apex of the head, second and third joints subequal in length and a little shorter than the fourth joint. Rostrum slightly passing the posterior coxæ, third joint longest, fourth a little shorter than the first. Body ovately elongate, depressed. Pronotum with the anterior margin strongly concave, the lateral margins entire or dentate, sinuate near centre, the lateral angles subprominent. Scutellum subtriangular, passing the centre of the abdomen, moderately tumid at base and gradually narrowing to about one fourth before apex, which is convexly rounded. Corium with its apical margin moderately sinuate. Membrane with the veins robust and longitudinal. Connexivum slightly notched or toothed at the incisures. Abdomen beneath with a broad basal furrow. Legs pilose; tibiæ sulcated.

Allied to the African genera *Cœnomorpha* and *Scribonia*.

Nevisanus orientalis, sp. n.

Ochraceous, thickly punctured with brassy black. Head with the lateral lobes, the margins of the central lobe, and the base very thickly punctate. Antennæ black, the base of the third joint narrowly and the bases of the fourth and fifth joints broadly ochraceous. Pronotum rugulose and thickly punctate, with the extreme anterior and lateral margins ochraceous, the last with the margins at lateral angles black. Scutellum with a levigate spot (variable in size) at basal angles, and a small central levigate basal spot ochraceous, apex and a central fascia from about centre very sparingly punctate. Corium thickly punctate, especially on disk and near base. Membrane black, with some apical pale spots. Connexivum ochraceous, broadly brassy black at the incisures. Body beneath and legs ochraceous, the lateral areas of the sternum and abdomen sparingly punctate; longitudinal fasciæ to head, transverse fasciæ to sternum, abdominal segmental margins, duplex marginal spots at the incisures, and a transverse streak near spiracles black. Legs with the femora punctured with black; tibiæ outwardly black at base and apex; apex of the tarsi black.

Long. 18–20 millim.

Hab. India, Sikkim, Khasia Hills.

Nevisanus nagaensis, sp. n.

Ochraceous; head, pronotum, and scutellum thickly covered with greenish-black punctures, the corium more sparingly so. Pronotum with the lateral margins coarsely dentate, the lateral angles subacutely prominent. Scutellum strongly transversely wrinkled at base, and with three pale spots on basal margin. Membrane cupreous, with the apex paler and the veins black, with subapical black spots between them. Connexivum ochraceous, greenish black at the incisures. Body beneath as above, but with the punctures much scarcer on the disk of the abdomen. Legs ochraceous, spotted with black. *Antennæ mutilated.*

Long. 20 millim.; lat. pronot. angl. 10 millim.

Hab. India, Naga Hills.

Nevisanus tectus.

Dalpada tecta, Walk. Cat. Het. i. p. 224. n. 17 (1867).

Hab. India, Silhet. Brit. Mus.

Apodiphus integriceps.

Apodiphus integriceps, Horváth, Rev. d'Ent. vii. p. 172 (1888).

This species was described from Turkestan. I possess two specimens from Silgeet, in Dardestan of the Kashmeer State, which agree fairly well with Dr. Horváth's description and are certainly quite distinct from *A. amygdali*, Germ. The anterior margin of the head is less cleft between the apices of the lateral lobes than in Germar's species.

Synonymical Notes.

Dalpada collocata, Walk. Cat. Het. i. p. 221. n. 13 (1867), belongs to the genus *Halyomorpha* and is very closely allied to *H. picus*, Fabr., if not but a variety of that species.

Dalpada apicifera, Walk. Cat. Het. i. p. 222. n. 14 (1867), =*Dalpada varia*, Dall. List Hem. i. p. 185. n. 8 (1851).

Walker's specimens are from Hong Kong and have the appearance of being discoloured by immersion in spirit.

Dalpada bulbifera, Walk. Cat. Het. i. p. 223. n. 16 (1867), =*Dalpada clavata*, Fabr.

Walker's type! is in far too mutilated a condition to have warranted description; and, although he allies it with his *D. nodifera*, the shape and structure of the head is quite different.

Dalpada brevivitta, Walk. Cat. Het. i. p. 224. n. 18 (1867).

This species does not, as stated by Walker, agree "in structure" with his *D. tecta*, which, as already mentioned, belongs to my genus *Nevisanus*. The shape of the head is totally different, and locates it rightly in the genus *Dalpada*.

Dalpada consobrina, Walk. Cat. Het. i. p. 225. n. 20 (1867), =*Dalpada clavata*, Fabr.

Dalpada brevis, Walk. Cat. Het. i. p. 226. n. 21 (1867),= *Dalpada remota*, Walk. ibid. p. 227. n. 22,=*Dalpada proxima*, Walk. ibid. p. 227. n. 23,=*Halyomorpha picus*, Fabr.

Dalpada japonica, Walk. Cat. Het. i. p. 228. n. 24 (1867), =*Erthesina fullo*, Thunb.

LXIII.—*On a new Beetle from Japan* (Omaliidæ).

By G. Lewis, F.L.S.

The curious insect to which this note refers was not submitted to Dr. Sharp while he was writing his second memoir on the Staphylinidæ of Japan in 1889, for by an error in grouping it was set aside as belonging to the Silphidæ; and it was only on my coming to write a description of it as such that I discovered my mistake. I then sent an example to Dr. Sharp, who kindly returned it to me with this memorandum :—"You may say in your description that it is the only species in the Staphylinidæ yet known in which the elytra are entire, not truncate, and completely cover the abdomen. In *Trigonodesmus* and *Lathrimæum* the wing-cases are truncate and leave the tip of the body exposed. It has a pair of ocelli, which brings it into the Omaliidæ."

Camioleum, gen. nov.

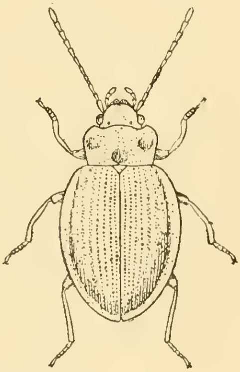
Resembles *Lathrimæum* and *Olophrum* in many of its characters, especially in the antennæ, palpi, and mouth-organs as they appear without dissection. Form depressed; the head somewhat transverse; eyes prominent and circular in outline; two ocelli before the neck; the thorax also a little transverse and widening out laterally, the expanding portions being equal to one third of the whole breadth; the elytra straight at the base, but otherwise completely oval in outline, sides much dilated and formed, especially in the epipleuræ, like *Silpha atrata*, L.; viewed from beneath they are widest behind the humeral angle, and behind the posterior coxæ the marginal expansion narrows and gradually ceases before the apex. The legs are slender and doubtless vary in structure in the sexes.

Camioleum loripes, sp. n.

Alutaceum, parum nitidum, depressum; elytris ovatis haud abbreviatis, striato-punctatis, marginaliter dilatatis.

L. 4 mill.

Alutaceous; disks of the head, thorax, and dorsum, with five terminal joints of the antennæ, darker; the antennæ are slender, with the joints relatively longer than in *Olophrum simplex*, Sh. (to compare them with a very common Japanese species), but otherwise the structure of the articulations is similar; the head uneven between the eyes, with irregular and scattered punctures; punctures smaller and fewer between the antennæ; epistoma smooth; the thorax margined on all sides with a faint stria, anterior margin bisinuous; angles rounded off, with the edge behind them feebly crenulate, posterior angles rectangular, sides dilated and slightly narrowed behind, punctured somewhat more coarsely than the head, surface uneven, with a fovea before the scutellum and two others, less distinct, placed longitudinally on each side of it near the margin (or they are merged in one, as in the figure); the scutellum triangular, with a few small punctures; the elytra complete, dilated along the outer edges, ovate, except at the base; dorsal area striate-punctate, sutural row of punctures and those next to it most distinct, outside the fifth row the punctures become denser and lose their linear arrangement; the basal segments of the abdomen are infuscate. Male: anterior and intermediate tibiæ widely bent; in the anterior pair the inner edge of the tibia is swollen and somewhat angular at the point where the bending ceases.



Hab. Main Island, near Kashiwagi, 19th June, 1881.

I found two males under some marsh-refuse; the female is not known to me.

LXIV.—*Notes on the Genus* Acronycta *of Authors and its Position in the Classification of Heterocerous Lepidoptera.* By A. G. BUTLER, F.L.S., F.Z.S., &c.

IN the 'Transactions of the Entomological Society' for 1879 I proposed (pp. 313–317) to break up the old genus *Acronycta* and distribute it, chiefly on account of its very distinctive larval characters, amongst the various families of Bombyces &c. to which the peculiarities of the larvæ seemed to show affinity. It must, however, be borne in mind that my conclusions were based chiefly upon the larvæ of the British species and the published illustrations of Abbot; nevertheless I examined the neuration of the species in each group, comparing it with that of each of the families to which the larval types seemed to point.

Unfortunately, at the time when I wrote my paper the importance of the position of certain veins in the wings of moths, as having more than generic value, was not so fully appreciated as at the present time; therefore, although I correctly represented the venation of the Notodontidæ, I failed to see that the position of the median branches and lower radial of the primaries in that family precluded the possibility of any *Acronycta* being regarded as even remotely allied to it. On the other hand, it is now known that the Liparidæ and Arctiidæ are much more nearly related to the Noctuæ than was formerly supposed; so that the similarity in neuration is by no means surprising, nor is there any reason why larval characters found in the former should not also occur in a genus of Noctuæ.

A recent study of the transformations of *Acronycta* in Abbot's unpublished volumes has now clearly shown that the differences in the clothing and outline of the larvæ characteristic of the Bombycid families already referred to occur in various species of the same group in *Acronycta*, and so are valueless as indicative of their affinities. I am therefore obliged to renounce my former opinion and admit that *Acronycta* is in truth a genus of Noctuæ, probably nearest allied to *Polia*.

The sections into which *Acronycta* has been divided may still be used (as having the value of numerals only) to indicate the near affinities of the species; and, as the Museum series is represented by nearly eighty species, I propose to indicate them below. I must, however, first point out that *Acronycta simplex* of Walker is *Xylomyges crucialis* of Harvey, and that *Hadena externa* of Walker (which I formerly placed in *Triæna*) is probably a very worn and stained specimen of *Bryophila muralis*, Forst.; its neuration certainly corresponds closely with that of *Bryophila*, and such markings as can be traced are also found in *B. muralis*. I have failed to recognize *Acronycta declarata*, Walk., *A. telum*, *interrupta*, and *pachycephala*, Guen.; though the description of *A. interrupta* is rather suggestive of *A. vinnula*, Grote, the absence of the illustration upon which M. Guenée based it from the Museum collection of drawings prevents its being satisfactorily identified. Possibly *A. telum* and *pachycephala* may be known to our American friends; but we possess no specimens so labelled.

Grote's group *Merolonche* seems to me to be far more distinct than the other sections of *Acronycta* and may perhaps prove to have generic value, the thicker antennæ of the males and the well-developed lateral anal tufts, combined with the regular fasciated character of the markings, should, I think, have some significance. *A. lithospila*, Grote, appears to me to be closely allied to the European *Scotochrosta pulla*, and cannot, I think, be an *Acronycta*; nor can I believe that *A. lanceolaria* and *insolita*, Grote, should be widely separated from the latter or from *Cucullia*. I therefore admit *Eulonche*, for these two species, as a genus.

One or two of the American species which have been wrongly identified I shall be obliged to rename.

ACRONYCTA (*Acronicta*, sic, Ochs.).

Typical Section.

1. *A. leporina*, Linn., and var. *bradyporina*, Treit. Europe.

*2. *A. felina*, Grote. United States.

3. *A. lepusculina*, Guen., and var. *populi*, Riley. Hudson's Bay &c.

*4. *A. insita*, Walk. United States and Canada.

*5. *A. innotata*, Guen. New York, Hudson's Bay, Canada, &c.

Of the above we possess the types of 2, 4, and 5. To save trouble I shall indicate all species of which we possess the type specimens by an asterisk.

Section Megacronycta, Grote.

1. *A. americana*, Harris.
    A. acericola?, *Guen.* New York and Foochow.

*2. *A. dactylina*, Grote. United States.

3. *A. hastulifera*, Sm. Abb.
    *♂. A. contacta, *Walk.* New York and Hudson's Bay.

In the Grote collection an example of *A. americana* was labelled *A. hastulifera*; but the figure corresponds far more closely with a female recognized as the latter and labelled by M. Guenée. We have a fourth species of this group from Ichang †.

Section Arctomyscis, Hübn.

1. *A. aceris*, Linn. Switzerland, Christiania, Livonia, &c.
2. *A. abscondita*, Treit. North Germany, Hungary.
3. *A. euphrasiæ*, Esper. Sicily, Russia.
4. *A. euphorbiæ*, Gmel. Switzerland, Germany, &c.

*5. *A. sperata*, Grote. New York.

*6. *A. tota*, Grote. Texas.

No. 6 is so much nearer to the dark variety of *A. aceris* than to any species of the section *Triæna*, that I have without hesitation placed it here.

Section Apatela, Grote (Apatelæ, part., Hübn.).

1. *A. hercules*, Feld. Yokohama and Tokio.
2. *A. rubricoma*, Guen. Philadelphia and Texas.
3. *A. luteicoma*, Grote. Kansas.

*4. *A. pallidicoma*, Grote. Illinois.

*5. *A. impressa*, Walk.
    A. fasciata, *Walk.*, and Verrillii, *Grote.*
    A. brumosa, *Grote* (not *Guen.*). Hudson's Bay &c.

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† I hesitate to describe the latter, Messrs. Leech and Oberthür having done so much work in the Chinese fauna of late years as to render such a course risky.

*6. *A. distans*, Grote. United States.

7. *A. megacephala*, Schiff. Zurich, Frankfort, &c.

8. *A. noctivaga*, Grote. New York and Canada.

9. *A. superans*, Guen. New York and Canada.

*10. ♀. *A. brumosa*, Guen.
  ♂. A. longa?, *Guen.*
  * ♀. A. persuasa, *Harv.* Florida and Yokohama.

*11. *A. perdita*, Grote. Sanzalito.

12. *A. afflicta*, Grote.
  A. brumosa, var., *Guen.* Florida.

13. *A. xyliniformis*, Guen. Rhode Island, Florida, &c.

*14. *A. extricata*, Grote. Texas? (locality not on labels).

15. *A. oblinita*, Sm. Abb. New York, Ohio, Nova Scotia, Canada, &c.

Section Lepitoreuma, Grote.

1. *A. rumicis*, Linn.
  A. diffusa, *Walk.* Zurich, Brussa, Turkey, Ichang, Japan.

2. *A. leucoptera*, Butl. Yokohama.

3. *A. impleta*, Walk.
  A. subochrea, *Grote* (on label and in Check-List, p. 23. n. 66). New York.

In Grote's Revised Check-List the author (p. 4) states that there is no such species as *A. subochrea.* If this is the case, how did he come to label one specimen as his type of that species, a second specimen as also "*Apatela subochrea*, Grote," and to include it in his Check-List of 1882? It may not be a distinct species from the following, but it is certain that at one time it was so regarded by Grote.

*4. *A. hamamelis*, Guen. United States.

Our example is evidently a co-type, though not mentioned by Guenée, since it still bears his label; probably as it has no abdomen he thought it not worth recording under the description.

*5. *A. hæsitata*, Grote. United States.

*6. *A. dentata*, Grote. United States.
*7. *A. increta*, Grote. New York.
*8. *A. dissecta*, Grote. Philadelphia, New York, Kansas.
*9. *A. clarescens*, Guen. Trenton Falls, New York, Nova Scotia.
*10. *A. modica*, Walk.
  *A. exilis, *Grote.* New York and Texas.
*11. *A. spinigera*, Guen.
  *A. Harveyana, *Grote.* New York.
*12. *A. ovata*, Grote. Texas.
*13. *A. alborufa*, Grote. New York.
*14. *A. grisea*, Walk. Hudson's Bay.

Section PHARETRA, Hübn.

1. *A. auricoma*, Schiff. Zurich, Livonia, &c.
2. *A. orientalis*, Mann. Bithynia.
3. *A. menyanthidis*, View. St. Petersburg, Berlin, &c.

Section TRIÆNA, Hübn.

1. *A. psi*, Linn. Regensburg &c.
*2. *A. increta*, Butl. Yokohama.
3. *A. tridens*, Gmel. Frankfort &c.
*4. *A. leucocuspis*, Butl. Yokohama and N. China.
*5. ♂. *A. lobeliæ*, Guen.
  * ♀. A. thoracica, *Grote.* New York.

6. *A. Grotei*, sp. n.
  A. lobeliæ, *Grote* (not *Guen.*).

Half as large again as *A. lobeliæ*, the longitudinal black streaks on the primaries slightly more elongated, but all the markings very similar: secondaries decidedly darker, with more golden gloss, the grey markings also darker. Expanse of wings, ♂ ♀ 56 millim. (one dwarfed male 47 millim.).

New York and Kansas.

It is possible that this may be no more than a large dark form of M. Guenée's species; but it is clear that it is not so regarded in America, and therefore I name it.

7. *A. furcifera*, Guen. New York.
8. *A. cuspis*, Treit. Germany.
9. *A. maxima*, Moore. Kúlú and Murree.
*10. *A. anœdina*, Butl. Hakodaté and Tokio.
11. *A. vinnula*, Grote. New Jersey.

12. *A. Smithii*, sp. n.
A. clarescens, *Grote* (not *Guen.*).

Primaries above chalky white, irrorated and clouded with sandy greyish or yellowish and grey mixed, somewhat after the manner of *A. morula*; the submedian basal black streak has somewhat the character of that of the true *A. clarescens*, only it is more elongated, sharply defined, and its upper margin is regularly tridentate; the reniform and orbicular spots are narrowly black-edged; the twin discal or post-median lines are sigmoidal and dentate-sinuate, the outer line being partly black; the subapical longitudinal dash is vague and diffused, and the dagger-mark has a brown background, which gives it a blurred appearance; in other respects the species is like *A. furcifera*, the male having whitish and the female more or less golden-brown secondaries with the usual markings. Expanse of wings 40–45 millim.

New York and Kansas.

*13. *A. pauperata*, Grote. United States.
14. *A. occidentalis*, Grote. Rhode Island, New York, Buffalo, Kansas.
"A. furcifera, *Pack.*" (not *Guen.*), on Zeller specimen.
15. *A. morula*, Grote. New York and Canada.
*16. *A. falcula*, Grote. United States.
*17. *A. parallela*, Grote. Colorado.
*18. *A. Radcliffei*, Grote. New York and Vancouver.
19. *A. tritona*, Hübn. New York and Florida.
20. *A. hasta*, Guen. "Amherst" (United States or Canada?).
*21. *A. quadrata*, Grote. Kansas.

Section HYBOMA, Hübn.

1. *A. strigosa*, Fabr. N. Russia, Livonia, &c.

*2. *A. nigrivitta*, Hamps. Nilgiris.
3. *A. divisa*, Moore. Dharmsala.

Section Jocheæra, Hübn.

1. *A. alni*, Linn. Ausbach, Livonia, &c.
*2. *A. connecta*, Grote. New York.

We also have a pretty species from Madagascar. It has probably been named by Herr Saalmüller or M. Mabille; but at present I cannot spare the time to look it up. Grote's *A. funeralis* is unknown to me, but (if confounded with *A. americana*) can hardly belong to the section *Jocheæra.*

Section Mastiphanes, Grote.

*1. *A. denticulata*, Moore. Dharmsala and Sabathu.
*2. *A. edolata*, Grote. Arizona.

Section Merolonche, Grote.

*1. *A. spinea*, Grote. California.
2. *A. Lupini*, Behr. Mendocino.

It is possible that one or two of the Japanese and Chinese forms enumerated above may be synonymous with species described from East Siberia; but the illustrations to the 'Lepidopteren Ost-Sibiriens' and 'Reisen und Forschungen im Amur-Lande' are so poor that, without seeing examples from the Amur, it would not be possible to be certain of the identity of the species, in a genus containing so many closely related forms.

LXV.—*Notes on some Mexican* Oryzomys.

By Oldfield Thomas.

Dr. A. C. Buller has lately sent to the British Museum a specimen of an *Oryzomys* from Jalisco which appears to be new, and in working this out I find that some confusion exists as to Alston's *Hesperomys Couesi*, in clearing up which a second species in the Museum collection proves to need description.

Hesperomys Couesi, Alston.

Hesperomys Couesi, Alston, P. Z. S. 1876, p. 756.

This species, described by Alston from three specimens now in the British Museum, has proved rather a stumbling-block to later workers, and this is not surprising, as an examination of his specimen shows that the three examples represent certainly two, and perhaps three, different species. The question therefore that at once arises is as to which of the three should be taken as the type, a question which, on the principle of the selection of the first-named species as the type of a genus, may best be settled by taking Mr. Alston's specimen *a* as the type of *H. Couesi*. This selection is supported both by the fact that the first five lines of the description itself are solely based on the spirit-specimen and also by Mr. Alston's known partiality to working on alcoholic material; so that no one who knew his methods would doubt as to which he himself would have chosen. I propose therefore for the future to look upon Mr. Salvin's spirit-specimen from Coban, Guatemala, whose measurements are given in Mr. Alston's first column, as the type of his *H. Couesi*.

Whether *c*, from Mexico (*Verreaux*), is or is not the same species I am at present unable definitely to decide; but that *b* is distinct from either is perfectly clear, its distinctive characters, both cranial and external, being more definite than are those separating any other two members of this difficult group.

The true *O. Couesi*, as represented by the type specimen, is a small species with slender limbs and long tail. Its colour is fulvous, darker along the centre of the back and paler, but not white, on the belly. The fur is fairly soft, but not thick and woolly as Alston stated, that remark evidently resting on specimen *b* (my *O. fulgens*). The measurements of the typical skull are given below and also those of the skull of an old male from the Hacienda Cubilguitz, about 25 miles north of Coban, which with some hesitation I refer to this species.

Oryzomys fulgens, sp. n.

Size large. Fur very thick, coarse, and woolly. General colour above bright fulvous, brighter than in any other Central-American species; anterior half of the body, including the head, rather paler and duller than the posterior half. Ears decidedly small, broadly rounded, thinly hairy, their hairs practically the same colour as those of the head in general, so that they are not distinguishable by colour at a distance. Lips, chin, throat, and inguinal region whitish, belly with a strong suffusion of fawn, which reaches a maximum on the breast between the fore legs; passage of upper colour into lower quite gradual. Outer sides of limbs like back, inner sides whitish; upper surfaces of hands and feet thinly clothed with pale silvery-fawn hairs. Tail long, thinly haired, the scales not hidden by the hairs; above blackish, below yellowish, darkening towards the tip.

Skull readily distinguishable from all allied species by its great breadth, the bold expansion of the zygomata, and especially by the evenly incurved outline of the supraorbital edges; in all other species these edges form two approximately straight lines diverging from the narrowest interorbital point, but in *O. fulgens* the whole inner wall of the orbit forms one even curve, the breadth at the posterior end of the olfactory chamber being scarcely greater than at the anterior end. Nasals broad and flattened. Frontal premaxillary processes very narrow and barely attaining to the same level as the back of the nasals. Anterior palatine foramina large, widely open, their posterior margin just level with the front of $\underline{\text{m. }1}$.

Measurements of the type (an adult male in skin):—

Head and body 160 millim.; tail 151; hind foot, without claw 35, with claw 37·5; ear (approximate) from notch 13·3.

Skull (see below).

Hab. Mexico. Coll. A. Boucard.

Type B.M. 70. 6. 20. 3. Purchased of Geale.

As already noted, this species is founded on specimen *b* of Mr. Alston's description of *Hesperomys Couesi.* Its exact locality unfortunately must remain unknown until further specimens of it are found; but its characters, both external and cranial, are so striking that I have no hesitation in describing it as a distinct species.

Oryzomys melanotis, sp. n.

Size small, form more slender and delicate than in the allied species. Fur straight, close and crisp. General colour grizzled rufous, brighter and clearer on the sides and rump. Lips, inner sides of limbs, and whole under surface white, the line of demarcation on sides well defined; the belly-hairs are, however, as usual slaty grey basally. Ears large, projecting far beyond the fur, closely covered with short black hairs, their black colour contrasting conspicuously with the general rufous colour of the head. Upper surfaces of hands and feet whitish. Tail long, very scantily haired, blackish above, whitish below.

Skull unusually broad considering its small size. Nasals very broad behind, surpassing in length the premaxillary processes. Interorbital space very broad. Supraorbital beads widely divergent. Anterior and posterior edges of interparietal forming two nearly equal curves. Anterior palatine foramina ending in front of $\frac{\text{m.}^{1}}{}$ a distance nearly equal to the length of $\frac{\text{m.}^{3}}{}$. Posterior nares widely open, rounded.

Teeth small and delicate.

Dimensions of the type (B.M. 93. 3. 6. 25), an old male in skin:—

Head and body 97 millim.; tail 127; hind foot, without claws (damped) 27, with claws 28; ear from notch 18.

Skull (see below).

Hab. Mineral San Sebastian, Jalisco, Mexico. Coll. Dr. A. C. Buller, Jan. 25, 1893.

The type specimen of this species being quite old, with the molar teeth much worn down, its small size will readily distinguish it from all its allies, except the still smaller *O. Alfari*, Allen, from Costa Rica.

Measurements of the Skulls of the above Species.

	Oryzomys Couesi.			
		Hacienda	*O. fulgens.*	*O. melanotis.*
	Type, ♀.	Cubilguitz, ♂.	Type, ♂.	Type, ♂.
	millim.	millim.	millim.	millim.
Basal length	(c.) 26·6	30·4	....	25·1
Upper length*	(c.) 30·5	34·8	(31·8†)	29·5
Zygomatic breadth ..	....	17·8	(c.) 17·8	(c.) 15·2
Nasals, length	11·1	14·1	13·2	12·0
Interorbital breadth ..	(c.) 5·2	5·9	4·8	5·1
Breadth of brain-case .	12·7	13·2	....	12·8
Interparietal, length ..	3·5	3·3	....	3·4
„ breadth..	7·9	7·8	....	10·0
Palate-length	....	17·7	....	15·5
Diastema............	8·6	9·3	9·1	8·1
Length of palatine foramina..........	6·2	7·0	7·2	5·8
Length of upper molar series	4·8	4·8	5·2	4·3

LXVI.—*Description of a new Species of* Perognathus *from Colorado.* By OLDFIELD THOMAS.

AMONG a series of what appear, from Dr. Merriam's able monograph, to be *Perognathus flavus*, Bd., collected by Mr. W. G. Smith in Colorado and acquired by the British Museum, there is a single specimen obviously different from

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* To back of interparietal, excluding supraoccipital.

† Interparietal lost; from back of parietal suture only.

the others, and, so far as I can make out, not referable to any hitherto known species. It may be termed

Perognathus infraluteus, sp. n.

Size small, about as in *P. longimembris*. Pelage soft. General colour above tending towards greyish olivaceous, decidedly more so than in *P. flavus*, but less than in *P. Lordi*. Lighter patches behind ears much reduced, scarcely perceptible; ears very small (but doubtfully quite perfect in the type), their infolded edges yellowish. Fulvous lateral band strongly defined from the dark upper surface, but extending beneath the body so as to cover the whole under surface except just the throat and the *centre* of the neck and breast; the limbs also wholly fulvous; the hairs of this fulvous underside everywhere slaty grey for their basal halves. This coloration, strikingly different as it is from the usual pure white under surface, seems to be only paralleled by that of Dr. Merriam's *P. olivaceus amœnus*, a very much larger animal. Soles hairy for their posterior half. Tail short-haired throughout, yellowish above, whitish below.

Skull of about the size and proportions of that of *P. longimembris*, but the mastoids are markedly less swollen, do not approach each other so much, and do not project backwards beyond the level of the occiput. The interparietal is consequently much broader, although of the usual length; it is in fact "broadly pentagonal," ratio of length to breadth 53 per cent. Frontal, median, and mastoid sides of parietals subequal and longest, about 4 millim. each.

Teeth.—$\underline{\text{M.}^3}$ very small, scarcely larger in section than the rounded anterior cusp of the premolar. Lower premolar rather larger than $\overline{\text{m. 3}}$, rounded quadrangular, its posterior side the longest.

Dimensions of the type (an adult female):—

Head and body (measured in flesh by collector) 60 millim.; tail 57; hind foot, without claw (damped and measured in skin) 14·9, with claw 16; hairy part of sole in centre 6·6.

Skull: basal length 17·3; basilar length of Hensel 15·3; greatest median length 21·2; greatest mastoid breadth 11·1; nasals, length 7·7; interorbital breadth 4·9; interparietal, length 2·7, breadth 5·1; least distance between mastoids above 5·2; combined lengths of three upper molars 1·9; ditto, three lower molars, 2·2.

Hab. Loveland, Larimer County, Colorado, 5000 feet. Coll. W. G. Smith, April 4, 1892.

This species is perhaps most nearly allied to *P. fasciatus*, Wied, from Montana, but it is readily distinguishable by its different coloration and somewhat smaller size.

LXVII.—*Description of a new Species of Tree Trap-door Spider from Trinidad.* By R. I. Pocock.

[Plate XIX. figs. 1-3.]

Mr. J. H. Hart has recently sent for determination to the British Museum a small series of insects and spiders from Trinidad. Three species of spiders were represented in the series: one of them is the well-known *Argiope argentata*; a second appears to be *Actinopus scalops* of Simon; the third, however, a species of *Pseudidiops*, appears to be undescribed. I propose therefore to name it in honour of its discoverer. It may be diagnosed as follows:—

Pseudidiops Hartii, sp. n.

Colour.—Carapace olivaceo-piceous, with black postero-lateral border and black ocular tubercles; abdomen purplish brown; legs mostly testaceous, but the whole of the patella and the distal end of the tibia black; tarsi reddish black; sternum and coxæ flavous, maxillæ and labium olivaceo-castaneous.

Carapace smooth, high, the posterior portion sloping upwards to the deep crescentic fovea; the area immediately in front of this fovea abruptly elevated, deeply longitudinally sulcate, and furnished on each side with a single large setiferous puncture; the area of the carapace between these punctures and the anterior border nearly flat, but bearing the two elevated ocular tubercles, the area between the two tubercles only a little larger than the diameter of the anterior eyes of the posterior tubercle, which is furnished with a strong seta between these eyes.

Mandibles weak, smooth above, furnished in front with long stiff setæ, the inner angle above the base of the fang produced into a short spicular prominence; fangs short but robust.

Labium separated from the sternum by a deep depression, narrowed in front, its distal border rounded, beset with long stiff setæ and armed with a transverse row of four short conical spines, behind which are two less conspicuous but similar spines.

Maxillæ covered with stout conical spines. The femoral segment of the palp furnished internally with a few irregularly arranged long setæ, which distally increase in stoutness and become spiniform; the *patella* armed internally with two long spines and furnished with a distinct tubercle externally; the *tibia* hairy beneath, but armed externally and internally with about two rows of strong spines; the *tarsus* similarly armed, the claw with a large basal tooth, which is itself also armed. The legs of the anterior pair armed like the palpi, except that the inner surfaces of the femur and patella are not armed with either spines or spiniform hairs and the anterior spines on the tibia are fewer. The second leg is, like the first, stout, the spines on the tibia still more reduced, those on the anterior surface becoming shorter and those on the posterior surface setiform and fewer. In the third leg there are a few small spines interspersed amongst the hairs on the anterior aspect of the patella and on the anterior and posterior aspects of the tibia; a few, too, only remain upon the proximal segment of the tarsus, which is, however, armed beneath with two strong long spurs. In the fourth leg the patella is armed with a few short spines in front and one behind; the tibia is furnished with setiform spines beneath and the proximal tarsal segment with a few long spines beneath. The claws of all the legs are armed with a large basal tooth, behind which, except in the posterior claws of the first and second leg, there is a second minute tooth.

The *abdomen* high and rounded. The anterior spinners shorter than the basal segment of the posterior, which are stout, three-jointed, and conical.

Length of carapace 6·5 millim., width 6; length of abdomen 8, width 6; length of maxillipede 12·8, of first leg 15·2, of second and third 13·8, of fourth 20.

Of this interesting genus *Pseudidiops*, with which *Dendricon* of Cambridge is synonymous, two species have been described *, and these are very probably identical.

Simon's original specimens were from Cayenne, and he has subsequently obtained the species from Venezuela. Unfortunately his description is very brief and is not accompanied by figures; so it is only possible to point out that this form from Trinidad appears to differ from his *opifex* in having the legs flavous and ringed with black. By the same character it may be recognized from the British-Museum example from Bahia, which Mr. Cambridge has described as *Dendricon rastratum* in the Proc. Zool. Soc. 1890, p. 623.

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* *Pseudidiops opifex*, Simon, Ann. Soc. Ent. Fr. (6) ix. p. 215 (1889).
Dendricon rastratum, Cambridge, Proc. Zool. Soc. 1889, p. 250.
(The description of *Pseudidiops* appeared on Sept. 11th, that of *Dendricon* on Oct. 1st. The former therefore has the priority.)

But it further differs from this last-named specimen in having the cephalothorax less elevated, a smaller distance between the two ocular tubercles, the eyes on the posterior tubercle set more closely together, and in possessing fewer spines on the labium.

The nest of this species, which was sent with the specimen, appears to resemble that of *P. rastratus* from Bahia. It is a short tube permanently closed at the bottom, with a hinged door at the entrance formed of closely woven silk threads, and perfectly smooth inside. The length of the tube from the hinge-margin to the bottom is only about twice the greatest diameter of the aperture. The surface by which it was attached to the tree-trunk is tolerably flat; the free surface, on the contrary, is strongly convex and thickly covered, as also is the door, with particles of bark. The shape of the cavity corresponds to that of the outside and of the door. The door, which is slender and with upturned edges, is wider one way than the other, *i. e.* its width from the hinge to the margin opposite to it is less than the width taken along a line at right angles to this measurement. It opens outwards and closes by the elasticity of its hinge. When closed the plane of its outer surface meets that of the trunk of the tree at an angle of about 45°.

Note 1.—In the nest of *Actinopus scalops*, which Mr. Hart sent with the specimens of this species, the hinge of the door is strengthened and protected by thick tough layers of greenish silk, so that the area above the hinge projects far above the rest of the surface of the door (Pl. XIX. fig. 3).

Note 2.—Mr. Hart forwarded with the specimens of *Argiope argentata* examples of the cocoons of that species. These cocoons show an interesting variation in colouring, being either bright yellow or green on both sides or green on one side and yellow on the other.

EXPLANATION OF PLATE XIX. FIGS. 1-3.

Fig. 1. *Pseudidiops Hartii*, sp. n., nat. size. 1 *a*. Lateral view of carapace. 1 *b*. Lateral view of upper part of carapace, to show arrangement of eyes and disposition of setæ. 1 *c*. Labium. 1 *d*. *Pseudidiops rastratus* (Cambr.), for comparison with fig. 1 *b*.

Fig. 2. Nest of *Pseudidiops Hartii*, sp. n.

Fig. 3. Nest of *Actinopus scalops*, Simon.

BIBLIOGRAPHICAL NOTICE.

The Fauna of British India, including Ceylon and Burma.—Moths. Vol. I. By G. F. Hampson. Edited by W. T. Blanford. Royal 8vo. With numerous Illustrations and 527 pages of letterpress. Published under the authority of the Secretary of State for India in Council. London: Taylor and Francis, 1892.

Without doubt Mr. Hampson's work is one of the most important contributions to entomological literature which has hitherto appeared—valuable alike to the student and collector of Indian moths, to whom it will be a priceless boon; to the cabinet worker who has to deal with the Heterocera of the world it will be a necessary text-book.

The classification of the families of Butterflies was studied in 1864 by the late Mr. H. W. Bates, and with such satisfactory results that his arrangement commended itself to all lepidopterists who took the trouble to test its accuracy; indeed, Bates's classification, with very slight modifications, is generally adopted at the present day. On the other hand, to form a key to the many families of Moths seemed such a stupendous task, that few men ventured to attempt it. The arrangements proposed by Messrs. Boisduval and Guenée were generally followed, and the blunders of these pioneers were copied and multiplied by their successors until the chaos into which the Heterocera were brought looked almost hopeless.

At length the study of the Tineina by Stainton and others and of the Noctuæ and Pyrales by Lederer began to throw a little light upon the obscurity; but entomologists still needed a guide to point out how, by the use of a simple pocket-lens and a little benzine, to decide at once whether a moth was a Geometer, a Noctuid, a Pyrale, and so forth.

In his 'Vlinders van Nederland' Heer P. C. T. Snellen eventually produced an admirable key to the families and genera of European Moths—a work unfortunately overlooked by most students of Exotic Lepidoptera; the confusion which therefore existed in public and private collections became year by year more confounded. Happily Mr. Hampson, when seeking a basis on which to found a general classification, discovered Snellen's key, and upon this, with slight modifications and many additions, he formed his classification of the Moths of the World.

In his Introduction Mr. Hampson has for the first time pointed out a character by which Moths can be distinguished from Butterflies, namely—all which resemble Butterflies in the possession of clubbed or dilated antennæ, also possess a frenulum, a character invariably wanting in the so-called Rhopalocera.

The descriptive matter and illustrations in the first volume of the Moths of India leave nothing to be desired, the former being terse and to the point, whilst in every genus one species is admirably figured, usually with accurate structural details, and in many instances a typical larva is represented. When absolutely necessary the synonymy of a species is given, but otherwise a reference to Cotes and Swinhoe's Catalogue of the Moths of India is substituted.

Touching the sinking of many described forms to the rank of synonyms, doubtless considerable differences of opinion will exist amongst lepidopterists; Mr. Hampson has used his private judgment in the matter, and, as an experienced collector of Indian Moths, his opinion must be allowed to have some weight. Without doubt the reduction of spurious species was much needed; but nevertheless the decision of no one man, however trustworthy, can be considered as final, until the life-history of many more species has been studied; because it is an acknowledged fact that, whereas some families of Moths are remarkable for their variability, others are almost as constant in all their characters. A. G. Butler.

MISCELLANEOUS.

New Observations on the Affinities of the different Groups of Gastropods (Expeditions of the Yacht 'Hirondelle'). By M. E.-L. Bouvier.

Gastropods are divided into two groups according as they are *unisexual* or *hermaphrodite*; the former (Prosobranchia) are further characterized by their decussating visceral commissure in the form of a figure of eight, while the latter (Opisthobranchia, Pulmonata, Pteropoda) are distinguished by their visceral commissure being more or less free from torsion. After a previous study * I had succeeded in partially removing the abnormal hiatus which an incomplete investigation had allowed to exist between these two groups, which I remained convinced must formerly have been united by a transitional form. If this form still existed it could only be found among the oldest Opisthobranchia, the Actæonidæ, which made their appearance in the Carboniferous period, and which are represented at the present time by the genus *Actæon*, of Triassic origin. Investigations which I have made upon specimens of *Actæon solidulus*, kindly handed over to me by M. Jousseaume, show that this Gastropod is, as a matter of fact, an ideal transitional form not only between the Prosobranchia and the Opisthobranchia, but also between the latter and the Pulmonata. As I have already published a succinct *résumé* of the organization and affinities of *Actæon* †, I shall here confine myself to an exposition of the general considerations to which the organization of this animal gives rise.

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* "Quelques observations anatomiques sur les Mollusques gastéropodes," Comptes rendus de la Société de Biologie, December 17, 1892.

† Société philomathique, séance du 24 décembre, 1892, and Société de Biologie, séance du 7 janvier, 1893.

The nervous system of *Actæon* * is decidedly chiastoneurous, like that of the Prosobranchia. The commissural ganglion on each side is fused with the corresponding cerebral ganglion. One of the branches of the visceral commissure starts from the left cerebro-commissural ganglion, travels obliquely from left to right and from front to rear, passing beneath the long buccal mass, and ends in the subintestinal ganglion, which is situated to the right close to the body-wall; the other branch is detached from the right cerebro-commissural ganglion, travels from right to left and from front to rear above the buccal mass, and ends in the supra-intestinal ganglion. Starting from this ganglion, which is situated upon the body-wall to the left, the commissural branch passes backwards, and, shortly before reaching the anus, inclines to the right above the œsophagus, and terminates in the visceral ganglion, which lies between the latter and the oviduct. In this same ganglion likewise terminates the prolongation of the subintestinal branch.

The supra-intestinal ganglion innervates the gill and the left portion of the mantle; the subintestinal ganglion emits a nerve which proceeds to the right portion of the latter organ. The innervation of the mantle is, however, a little further complicated, owing to the presence of two small accessory ganglia, which we may term *secondary pallial ganglia*, and which are the more important since they will enable the chiastoneurous nervous system of *Actæon* to transform itself by degrees into an orthoneurous system. The first of these ganglia is situated upon the subintestinal branch, midway between the left cerebro-commissural ganglion and the subintestinal ganglion; it innervates the left portion of the mantle: the second is found upon the supra-intestinal branch, in the immediate neighbourhood of the right cerebro-commissural ganglion; it innervates the right portion of the mantle. Thus the left portion of the mantle receives at the same time the nerves of the supra-intestinal ganglion and of the left secondary pallial ganglion, while the right portion is innervated by the subintestinal ganglion and the right secondary pallial ganglion.

From the foregoing it is clear that *Actæon* is directly connected with the Prosobranchia, and, if we take into consideration the characters of the bipectinated gill, with the diotocardiac division of the latter. We now have to consider by what process it has been possible for them to give rise to orthoneurous descendants, that is to say to the other Opisthobranchia and to the Pulmonata.

It has been shown by Bütschli that it would be possible to derive the Gastropoda from a dibranchiate primitive form, the two gills of which would have been situated symmetrically *behind*, the one to the right, the other to the left of the anus; this primitive form had

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* Our knowledge of the nervous system of *Actæon* is based upon a figure by M. Pelseneer ('Challenger' Pteropoda, pl. ii. fig. 11). The cerebral and pedal centres are distinctly shown, but the visceral commissure is incompletely figured; however, it is merely a repetition of the scarcely twisted commissure of the normal Tectibranchia.

an orthoneurous visceral commissure, upon which we may imagine, to be concise, two symmetrical pallio-branchial ganglia, innervating symmetrically the gill and the mantle of the same side. The whole of this symmetrical apparatus has been transported, owing to the peculiar mode of growth, to the right and towards the front, and has finally come to occupy a symmetrical dorsal position, as we still find it in *Fissurella*. The primitive right gill is therefore found to the left, and the left to the right; moreover, since the gills carry with them the ganglia which innervate them, the visceral commissure became chiastoneurous. Later on the right gill (primitive left) atrophied, and Gastropods were produced provided with the single left gill (primitive right) such as we find in the great majority of the Prosobranchia and also in *Actæon*.

But then there took place a displacement of the gill in precisely the opposite direction. The persisting left gill returned towards the rear and to the right, carrying with it its ganglion (the supra-intestinal) and the supra-intestinal commissural branch, which came to lie on the right side of the œsophagus.

The branchial ganglion (primitively supra-intestinal) probably became fused with the right secondary pallial ganglion; it no longer sent nerve-branches into the left portions of the mantle, which were too far off, but it innervated the regions of this organ which are situated to the right, that is to say in the neighbourhood of the gill. The subintestinal ganglion, having become useless, atrophied altogether, at the same time as was developed the left secondary pallial ganglion, which carried to the left of the œsophagus the subintestinal commissural branch, and assumed the sole control of the innervation of the left portions of the mantle (*Acera bullata* and aquatic Pulmonata). In the other Opisthobranchiate forms the left secondary pallial ganglion has approached much nearer to the visceral ganglion or has even become fused with it. In all cases the visceral commissure has become more or less decidedly orthoneurous, and this arrangement has enabled the nervous centres situated upon the commissure to approach one another very nearly, and even to fuse together (Nudibranchia, certain Pteropoda, and terrestrial Pulmonata). The Pulmonata are directly connected with the Actæonidæ by their branchiferous (*Siphonaria*) and operculate (*Amphibola*) species, and there can no longer be any question of establishing in the class Mollusca two parallel series independent one of the other. —*Comptes Rendus*, t. cxvi. no. 2 (January 9, 1893), pp. 68–70.

On the Branchial Sense-Organs of the Patellidæ.

By Dr. J. Thiele, of Dresden.

When I was examining some time ago a series of transverse sections which I had prepared of a specimen of *Patina pellucida*, my attention was attracted by a button-shaped projection of the epithelium at the sides of the body between the foot and mantle which could hardly be anything else than a sense-organ. For the moment

I thought of an equivalent to the lateral organs of Rhipidoglossa, but then noticed that the organ was present only in the foremost portion of the lateral mantle-chamber, and I therefore assumed that a connexion existed with the rudimentary gills or organs of Spengel. The mode of preservation of the animal under investigation was not such as to enable a clear idea of the innervation to be obtained, and therefore in a figure of *Patinella deaurata* recently published with another object ("Beiträge zur Kenntnis der Mollusken.—1. Ueber das Epipodium," Zeitschr. f. wiss. Zool. 53 Bd., Taf. xxiii. fig. 3), which shows a thickened streak at the spot indicated, I had designated this simply as "sense-organ" ("Sinnesorgan").

A short time ago I received some well-preserved specimens of *Patina pellucida* from Heligoland, and in a series of sections I have found the sense-organ again very distinctly, and have determined its innervation. The nerve, which runs beneath the streak of sensory epithelium, proceeds from the olfactory ganglion of Spengel; it is on the whole feebly developed and not altogether easy to distinguish between the fibres of the retractor muscle, though most distinct in front. The epithelial band is fairly broad at the spot where it encircles the retractors in front; from this point it becomes still broader towards the middle, and the cells become flatter, while at the outer side it soon narrows considerably, while the columnar cells diverge fan-wise; at this spot it differs most from the surrounding epithelium, though the entire streak exhibits the characteristics of sensory epithelium in a well-marked degree.

With reference to the dissemination of this organ, it may be remarked that it is possible that it occurs in all Patellidæ, excluding *Acmæa* and *Lepeta*, since I have traced it in *Patella cærulea* in sections and have seen it macroscopically in *Patinella*, two forms which are not far distant from the terminal points of the phyletic developmental series.

Neither Spengel ("Die Geruchsorgane und das Nervensystem von Mollusken," Zeitschr. f. wiss. Zool. 35 Bd.) nor Bernard ("Organes palléaux des Prosobranches," Ann. Sc. Nat. vii. 9), who has recently minutely investigated the branchial sense-organs of the Prosobranchia, have noticed this prolongation of them at the sides of the body in Patellidæ, but have only observed the portion which is in immediate connexion with the nuchal papillæ, the rudiments of the Zygobranch gills. Bernard even expressly states with regard to *Patina pellucida* that "the organ of Spengel is situated entirely behind the ganglion." The course of the organ as described above appears to me to be not without importance, and I therefore wished to give a provisional account of the fact; I shall revert to it later on in greater detail.—*Zoologischer Anzeiger*, xvi. Jahrg., no. 412 (February 13, 1893), pp. 49, 50.

On Cirripedes and other Crustaceans commensal with Mediterranean Turtles. By MM. E. Chevreux and J. de Guerne.

It is seldom that the opportunity is presented to zoologists of observing the pelagic Vertebrates at sea under the normal conditions of their existence. Accordingly on board the 'Hirondelle,' as well as the yachts 'Actif' and 'Melita,' we have both of us always examined with great care all those which chance brought within our reach, and especially the Turtles.

Two of these animals, *Thalassochelys caretta*, L., were captured in 1892 between Algeria and the Balearic Isles during the last scientific voyage of the schooner 'Melita.' On July 7th, in lat. 37° 55′ N. and long. 0° 40′ E., two turtles were descried. One was floating on its back, beating the air with its feet; the other was swimming at considerable speed round its companion, and on the arrival of the boat it dived and disappeared, while the latter allowed itself to be taken without endeavouring to escape.

The carapace of this turtle was fairly clean, but a few Cirripedes were attached to it, including specimens of *Lepas Hilli*, Leach, some very young *Conchoderma virgatum*, Speng., and a fine example of *Platylepas bissexlobata*, Blainv. A certain number of Amphipods (sixteen *Hyale Grimaldii*, Chevreux, one *Platophium chelonophilum*, Chevreux and de Guerne, and one *Caprella acutifrons*, Latr.) were collected among the *Lepas*; four specimens of *Tanais Cavolinii*, M.-Edwards, were ensconced in the interstices of the dorsal plates; and, lastly, three *Nautilograpsus minutus*, L., were attached to the tail of the Chelonian, shielded by the posterior margin of the carapace.

The second turtle was captured in the same region on August 2nd, in lat. 37° 26′ N. and long. 0° 50′ E. Its carapace was plentifully garnished with Cirripedes (of the same species as those above, in larger numbers) and Algæ (*Polysiphonia sertularioides*, Grat., a Mediterranean species common on the coast of Algeria. In the Algæ were found two hundred and fifty-nine specimens of *Hyale Grimaldii*, one *Platophium chelonophilum*, and several hundred *Caprella acutifrons*. Five *Tanais Cavolinii* were hidden between the plates of the carapace and two *Nautilograpsus minutus* were attached behind in the position already indicated.

These crabs are adult specimens of large size; on the first turtle were found two males and an oviferous female, on the second one male and an oviferous female. It will be noticed what is apparently the constant position occupied by these Crustaceans upon Chelonians. It is the only one where they are almost certainly protected from the pursuit of the *Thalassochelys*, which devour them readily, just as they free one another from the stalked Cirripedes attached to their carapaces by eating them *.

Hyale Grimaldii was recently described by one of us from two male specimens collected upon a piece of wreckage among the *Ulva* during the fourth expedition of the 'Hirondelle,' in lat. 42° 9′ 24″ N., and long. 23° 33′ W. It is the only species of the genus *Hyale* which, so far as is known at present, can be considered as exclusively pelagic. It is true that in the Azores *Hyale camptonyx*, Heller, and *H. Stebbingii*, Chevreux, have been found by M. Th. Barrois upon a beam covered with barnacles, which was stranded not long since in the Bay of Ponta-Delgada. But these two species are common on the shores of the Archipelago; the former abounds in

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* G. Pouchet and J. de Guerne, "Sur l'alimentation des Tortues marines," Comptes Rendus, April 12, 1886.

the Mediterranean and is found along the Atlantic coast of Europe as far up as Saint-Jean-de-Luz (Basses-Pyrénées); the latter, which apparently ought to be regarded as an insular form, and was obtained for the first time by one of us at Fayal in 1887, and then at Fayal, Florès, and Rosario de Corvo in 1888 (third and fourth expeditions of the 'Hirondelle'), was met with again during the voyages of the 'Melita' in the Canaries and in Corsica. The numerous colony of *Hyale Grimaldii* attached to the second of our turtles comprised adult males, oviferous females, and young individuals of all ages. Their colour was noted down at once; the body is orange-brown, the antennæ and legs violaceous pink, the eyes black.

Platophium (*Cyrtophium*) *chelonophilum*, described from the numerous specimens obtained by the 'Hirondelle' *, has never been met with except upon turtles. The 'Challenger' expedition captured a single specimen of the species, a young one, upon a *Chelonia imbricata*, L., from the Atlantic †. An adult female was found upon the first of our *Thalassochelys* and an adult male upon the second.

The very numerous examples of *Caprella acutifrons* (comprising adult males and females and young of all sizes) belong to the well-characterized variety described by M. Mayer under the name *forma Andreæ,* which appears to be exclusively pelagic. This form may be said to be of universal distribution; specimens of it are known from the Gulf of Naples, the North Atlantic, the Pacific Ocean (voyage of the 'Galathée'), the Sea of Japan, and the Strait of Corea, all of which were found upon wreckage in company with *Lepas* and Hydroids, except a female which was obtained upon a turtle in lat. 38° 10′ N. and long. 64° 20′ W.

Tanais Cavolinii, on the contrary, is a littoral species, which is common in the Mediterranean. It has been reported from the Adriatic (*Heller*) and the Azores (*Th. Barrois*).

Lepas Hilli and *Conchoderma virgatum* do not give rise to any special remark. The second of these Cirripedes belongs to the variety *chelonophilum*, Leach.

Platylepas bissexlobata, which was mentioned by Bivona as long ago as 1832 as occurring upon the turtles of the Mediterranean, does not appear to have been noticed there again. It is, however, although it seems to have been seldom observed, a species of world-wide distribution. Darwin considered it to be identical with that which is found upon the manatees of the tropical Atlantic and upon the dugongs of Australia. Perhaps it may even occur on the shores of California.—*Comptes Rendus*, t. cxvi. no. 9 (Feb. 27, 1893), pp. 443–445: from a separate impression, communicated by the Authors.

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* E. Chevreux and J. de Guerne, "Sur un Amphipode nouveau, *Cyrtophium chelonophilum*, commensal de *Thalassochelys caretta*, L." ('Comptes Rendus,' Feb. 27, 1888). A turtle belonging to the same species, captured on Aug. 6, 1888, in the neighbourhood of the Azores, in lat. 39° 41′ 35″ N. and long. 33° 24′ 22″ W., during the fourth expedition of the 'Hirondelle,' likewise furnished a very large number of *P. chelonophilum*.

† The locality is not indicated, but it is probable that it is the most southerly of those where *P. chelonophilum* has been taken, considering the habitat of *Chelonia imbricata*.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

No. 66. JUNE 1893.

LXVIII.—*On new Species of* Histeridæ, *and Notes on others.* By G. Lewis, F.L.S.

[Plate XX. A.]

This is the eleventh paper on the Histeridæ in the pages of this Magazine, the present one being a continuation from vol. x. (1892), p. 236. The last communication referred to the genera *Eretmotus* and *Epiechinus* only.

Three curious species are figured here, viz. *Dimalus platamodes*, Mars. (Plate XX. A, fig. 1), *Ebonius politus*, Lew. (Plate XX. A, figs. 2, 2*a*, *b*), and *Monoplius pinguis*, Lew. (Plate XX. A, fig. 3); the drawings for the illustrations were made from specimens in the National Museum, and as the species are at present extremely rare in collections, it is thought the figures will interest entomologists.

List of Species.

Hololepta sidnensis, *Mars.*
—— *Mastersii*, MacL.
Apobletes difficilis, *Sch.*
—— *difficile* (Platysoma), *Sch.*
—— *Semperi* (Apobletes), *Lew.*
Platylister (Platysoma) Gorhami, *Lew.*
—— nemoralis.
—— andamanensis.
Platysoma persimile.
Psiloscelis carinicollis.
Contipus piraticus.
Homalopygus cavifrons.
Trichoreninus imbricatus.
oryphæus pilosus.
ynodites Schmidti.
uclasea pauperella.
—— tuberculata.
—— obliqua.
Trypeticus rhinocerus.
—— bifoveolatus.
Teretriosoma afrum.
—— Hornii, *Lew.*
Teretrius australis.
Acritus Lightfooti.

Hololepta Mastersii, MacLeay, 1882 = *H. sidnensis*, Mars. 1860.

I have determined this synonymy on the authority of one of Mr. Masters's specimens sent to me by Mr. Olliff. MacLeay, in his description of *H. Mastersii*, writes of the pygidium instead of the propygidium as being punctate. The pygidium is smooth.

Apobletes difficilis.

Apobletes Semperi, Lew. 1891 = *Platysoma difficile*, Sch. 1889.

Some of the species in the genus *Apobletes* are so similar to some of those in *Platysoma* in their general aspect that it is not always easy to separate them. Herr Schmidt's trivial name has precedence to mine; but I think the species should be placed in *Apobletes* on account of the width of the prosternum.

Platysoma Gorhami, Lew.

This species was given to me as a capture made by Dr. Livingston in Africa; but I have others taken in the Philippine Islands by Dr. Semper, and it is evident the first locality is an erroneous one. The species belongs to the newly-made genus *Platylister*, a genus apparently confined to the Oriental region, the Malayan Archipelago and the Pacific Islands giving the greater number; but there are some in India and in the countries east of it. None are known west of Bombay; and a single species in South Japan, *P. pini*, Lew., seems to mark its eastern limit.

Platylister nemoralis, sp. n.

Oblongo-ovatus, parum convexus, niger, nitidus; elytris striis 1^a–2^a integris, 3^a in medio interrupta, suturali brevissima; prosterno haud striato, lato et impunctato; mesosterno late emarginato, stria marginali integra.

L. 5 mill.

Oblong-oval, rather convex, black, shining; the forehead concave, stria bisinuous; the thorax—anterior angles a little depressed and well produced, stria laterally strong and nearly straight, leaving a margin somewhat similar to that of *Platysoma Confucii*, Mars., but it is as wide again, behind the head the stria is somewhat fine, and near the angles it runs close to the thoracic edge, but behind the neck it leaves rather a wider margin than in *Platysoma abruptum*, Mars., and other similar species; the elytra—striæ 1–2 complete and strong, 3 interrupted in the middle, 4 represented apically by two punctures, 5 by one point, the sutural is very short, occupying a place over the hind coxæ; the propygidium transversely punctured, impressed slightly on either side; the pygidium is evenly but not thickly punctate, with the outer margin moderately elevated; the anterior tibiæ are 4-dentate, the tooth nearest the base being very small.

Hab. Martapura, S.E. Borneo (*Doherty*, 1891).

Platylister andamanensis, sp. n.

Oblongo-ovatus, depressus, niger, nitidus, minutissime punctulatus; fronte excavata; pronoto stria laterali valide impressa in medio sinuata; elytris striis 1^a–3^m integris, 4^a dimidiata, 5^a ultra medium abbreviata; propygidio pygidioque punctatis.

L. $3\frac{2}{3}$ mill.

Oblong-oval, depressed, black, shining, surface microscopically punctulate; the forehead and epistoma deeply excavated, stria complete and feebly sinuous in front; the thorax—lateral stria strong, like that of *Platysoma Confucii*, Mars., but more sinuous in the middle, anteriorly the stria is feebly crenulate and obscurely interrupted behind the eye, and again more clearly but narrowly in the middle; the elytra—striæ 1–3 complete, 4 apical, reaching the middle, 5 a little longer and for half its length it bends slightly away from the suture; the propygidium punctured throughout, punctures largest at the sides and of a smaller grade in the middle; the pygidium evenly punctate, punctures rather closely set, impressed on each side, with the posterior margin moderately raised; the prosternum—lobe punctured evenly with rather small points, with an arched lateral stria like that of *Platysoma Confucii*, Mars., keel and the surface of the other sternal plates with very fine punctures, evenly but widely set, without a marginal stria; the mesosternum rather widely emarginate, stria complete and formed like that of *P. Confucii*, Mars.; the anterior tibiæ 4-dentate.

Hab. Andaman Islands (*Ræpestorf*).

Platysoma persimile, sp. n.

Oblongo-ovatum, subdepressum, nigrum, nitidum; fronte impunctata; pronoto lævi, stria antice interrupta: elytris striis 1^a–3^m integris, 4^a–5^a apicalibus; pygidio impunctato; mesosterno antice haud striato.

L. 4 mill.

Oblong-oval, black, shining; the head impunctate, frontal stria complete; the thorax—lateral stria deep and feebly sinuous near the middle, anteriorly interrupted behind the neck; the elytra—striæ 1–3 complete, 4–5 apical; the propygidium with an irregular transverse band of punctures at the base; the pygidium smooth; the prosternum—keel a little narrowed before the coxæ, without striæ; the mesosternum with a lateral stria only, which is incurved at the anterior angle.

This species is a little broader and flatter than *Platysoma Confucii*, Mars.; the pygidium smooth, and the mesosternal stria does not continue anteriorly. The striation of the head, thorax, and elytra is, however, almost identical in both species.

Hab. Buru (*Doherty*, 1892).

Psiloscelis carinicollis, sp. n.

Oblongo-ovatus, niger, nitidus; fronte in medio profunde impressa: thorace marginato, laterali elevato, utrinque carinato, parce punctato; elytris striis 1^{a}–4^{m} integris, 5^{a}–6^{a} antice conjunctis; pygidio dense punctato, opaco.

L. 5 mill.

Oblong-oval, black, shining; the forehead margined with a carina, arched at the sides, straight in front, median portion smooth and deeply impressed, dividing the disk into two small bosses in the punctulate surfaces; the thorax sparsely punctured, with very fine points in the interspaces, marginal striæ fine and complete, with the lateral margin elevated, and within is a feebly sinuous detached carina, which is a little shortened anteriorly and more abbreviated behind; the elytra —striæ 1–4 complete, 5 and sutural also complete and joined at the base; the propygidium has oblong punctures, not closely set, with fine punctures between them; the pygidium has a similar sculpture, but the punctures are dense and give an appearance of opacity, there is a feeble median carina before the apex to be seen only in certain lights; the prosternum—keel very finely carinate at the sides and base, narrow anteriorly, triangularly widening out at the base; the mesosternum smooth, feebly sinuous in front, with a very fine marginal stria; the tibiæ—anterior 7–8-spinous, dilated and arched on the outer edge, intermediate and posterior multispinous and truncate before the tarsi.

Hab. Borneo (*Doherty*).

Contipus piraticus, sp. n.

Histeri latitibio proxime affinis; fronte stria integra antice recta; elytris striis 1^{a}–3^{m} integris, 4^{a} basi abbreviata, suturali nulla; tibiis anticis 3-dentatis.

L. 8–8½ mill.

Oblong-oval, black, shining; the forehead impunctulate, stria complete and straight anteriorly; the thorax—marginal stria rather fine, incurved at the base, terminating in front behind the eye, inner stria complete, rather strong, deflected behind the eye, interstices between the striæ somewhat wide; the elytra—humeral striæ formed as in *H. latitibius*, but fine, dorsal 1–3 complete, 4 little shortened at the base, 5 apical, terminating before the middle; the propygidium moderately punctured, impressed on either side; the pygidium evenly and densely punctured on its upper surface, apex smooth; the prosternum—keel narrow before the coxæ and without sculpture; the mesosternum emarginate, with a fine stria laterally, stria obsolete in front; the tibiæ are very broad, anterior pair 3-dentate, the others spinose on the outer edge; tarsi very short.

This species is larger than *Hister latitibius*, Mars.; the chief differences are—the inner thoracic stria is not shortened at the base, the sutural dorsal stria is absent, and the mesosternum has no clearly marked marginal stria. In one example the frontal stria is sinuous anteriorly. *Hister latitibius* is now considered to be a *Contipus* (Ann. Mus. Civ. Genov. vol. xii. 1891, p. 23).

Hab. Dutch Timor (*Doherty*, 1892).

Homalopygus cavifrons, sp. n.

Oblongo-ovalis, rufo-brunneus, nitidus; antennis pedibusque concoloribus; fronte excavata, punctata, utrinque striata; elytris striis 1^a–3^m integris, suturali antice et postice abbreviata.

L. 3 mill.

Oblong-oval, reddish brown, shining; the forehead sparsely punctate, with a stria over the eye, excavated between the antennæ, excavation angulated posteriorly; the thorax—marginal stria fine, invisible above at the sides, feebly crenulate behind the neck, anterior angles rounded off, punctuation rather large at and behind the anterior angle and continuing less thickly to the hind angle, punctures evanescent on the disk and before the scutellum; the elytra—striæ 1–3 complete and crenulate at the edges, 4 apical and punctiform, scarcely traceable, sutural fine, commencing at the middle and shortened before the apex, there are a few scattered punctures on the apical portions of the elytral interstices and on the interspace between the fourth and sutural striæ; the propygidium and pygidium are clearly, not thickly, punctured, the punctuation of the latter is a little smaller; the prosternum is truncate at the base, striate, striæ feebly crenulate, joining at the base, diverging anteriorly, and terminating before the suture, anterior lobe punctate; the mesosternum straight anteriorly, margined with a crenulate stria, which joins a similar one at the metasternal suture; the anterior tibiæ are 6–7-dentate, but the tibiæ are not dilated.

Hab. Rio Janeiro (*Fry*).

Several specimens.

Trichoreninus imbricatus, sp. n.

Ovalis, brunneus, parum convexus; pronoto lateralibus bistriato, in medio grosse ovato-punctato; mesosterno utrinque bisulcato; pedibus valde dilatatis.

L. $1\frac{2}{3}$ mill.

Oval, somewhat convex, brown, shining, sparsely setose; the forehead densely and minutely rugose, striæ sinuous laterally and well-marked, not joining in front, surface with a few large shallow punctures irregularly set; the thorax transverse, oblique at the anterior angles, laterally bistriate, both striæ sinuous, the inner stria touches the outer one at the base, then gradually widens out, leaving a wide interstice behind the anterior angle, where it ceases, the outer stria leaves a somewhat wide interstice between it and the outer edge before the middle, and before the anterior angle it is marginal, and as such ceases behind the eye, behind the eye there is an inner transverse stria which joins the outer stria at the margin, the disk of the thorax has large oval punctures (remarkable for their size), somewhat scattered and irregular, the edge at the base has smaller oval punctures regularly set along it; the elytra—striæ, first fine and complete, touching the base, second and third shortened and hamate before the base, fourth resembles the third at the base, widening out afterwards into a rather broad shallow groove on the dorsum and ends apically in large punctures, fifth apical and punctiform, sutural is a shallow groove, interrupted narrowly before the base and punctiform apically; the propygidium is microscopically sculptured with a few large shallow punctures, each one bears a seta; the pygidium is similar; the prosternum—the anterior lobe is excavated laterally, with a raised median portion, which serves as a prolongation of the keel, keel with setæ which seem to follow obsolete striæ; the mesosternum bisinuous, obtusely produced, marginate, with two lateral sulci, which are also common to the metasternum; the first abdominal segment has a row of large oval punctures on the anterior edge; the tibiæ are widely dilated.

Hab. Bahia.

Coryphæus pilosus, sp. n.

Breviter ovatus, parum convexus, viridi-cyaneus, pilosus, supra punctulatus; fronte in medio canaliculata; pronoto convexo; elytris striis 1^{a}–3^{m} subintegris; prosterno bistriato; mesosterno immarginato, antice subacute producto.
L. 6½ mill.

Shortly oval, little convex, pilose, entirely and rather densely punctulate above, greenish blue, metallic; the forehead with a shallow median channel, which divides in front and forms a rather broad hamate impression along the anterior edge, the lateral stria over the eyes is very obscurely marked, if not obsolete; the thorax—lateral margin very narrow and punctulate, and within it a lateral band of large grater-like punctures (Marseul called similar punctures in *C. Wallacei* "râpeux"), the band is narrower than in Marseul's species and inclined to be broken in the middle, and is widest behind the anterior angle, in front of the scutellum there is a minute shining boss; the scutellum is very small, triangular, and quite smooth; the elytra—striæ, subhumeral arched and not well-marked, humeral evanescent towards the apex, dorsal 1–3 rather wide but shallow and terminating apically in punctulate impressions, the dorsal disk is uneven and is free from the brown pilosity; the propygidium and pygidium are much less cyaneous than the elytra, but are similarly punctulate; the prosternum bistriate, striæ joining anteriorly, keel finely punctulate; the mesosternum rather acutely produced in front, immarginate, punctulate like the keel; the femora greenish, tibiæ brownish and pilose, formed as in *C. Wallacei*, the tarsal grooves of the anterior tibiæ being shallow, and the outer edges of the tibiæ are straight.

Hab. Tenimber (*Doherty*).

This species differs chiefly from *C. Wallacei*, Mars., in being pilose and wholly punctulate above, with thorax convex at the sides as well as on the disk, and by the metasternum being somewhat acutely produced anteriorly. Marseul published the genus *Coryphæus* in 1864, but in 1869 he placed it in a supplementary Catalogue (Ann. Soc. Ent. Belgique, xiii. p. 133) as a subgenus of *Pachycrærus*. It is entitled to full generic rank, and I think the position assigned to it in this paper better than placing it near *Pachycrærus*.

Synoditus Schmidti, sp. n.

Ovatus, setosus, piceus, nitidus, pedibus concoloribus; elytris striis integris punctiformibus, interstitiis lævibus; prosterno bicarinato, carinis antice conjunctis; mesosterno laterali grosse punctato; pygidio apice lævi.

L. 1½ mill.

Oval, convex, setose, piceous; the forehead carinate on the sides, carinæ meeting and forming an angle anteriorly, surface entirely covered with large shallow confluent punctures; the thorax—lateral stria well marked, but behind the head the stria is partly obliterated by the punctuation, anterior angles feebly prominent, somewhat like an *Eretmotus*, surface rather thickly covered with large oblong, or somewhat tear-shaped punctures, punctuation conspicuous; the elytra—humeral and first to fourth striæ complete, fifth shortened and evanescent at either end, sutural straight and parallel to the suture, all formed by double rows of punctures, the striæ close in together at the apex forming a punctured area, the striæ 1–4 are arched, the fourth joining the sutural at the base, interstices smooth; the propygidium and the pygidium closely and roughly sculptured with large confluent punctures, the latter being smooth at the apex; the prosternum—lobe coarsely rugose, keel carinate at the sides, carinæ joining in an arch anteriorly and gradually diverging to the base, area between the carinæ smooth; close to the carina, between it and the coxæ, is a short curved stria; the mesosternum—margin raised correspondingly to the prosternal carinæ, prominent and obtusely angulate anteriorly, the projection is sculptured, but the surface immediately behind is narrowly smooth and posteriorly joins a large smooth triangular space which occupies nearly the whole of the metasternum; the meso- and the metasternum are broadly bordered laterally with large, somewhat confluent, punctures, and the latter has a few similar punctures along its base; anterior tibiæ denticulate, intermediate angulate on the outer edge before the base.

My friend and correspondent Herr Joh. Schmidt, who has lately enunciated the genus *Synoditus* and described six species in it, has examined the above and returned it to me as an undescribed species, and I have much pleasure in naming it after him.

Hab. Bahia.

Euclasea pauperella, sp. n.

Breviter ovata, rufo-brunnea, nitida; mesosterno marginato, in medio triangulariter producto; metasterno haud tuberculato.

L. 1⅓ mill.

Shortly oval, reddish brown, shining, wholly engraved above with a fine and dense sculpture; the forehead—stria complete, feebly sinuous at the sides, bowed behind the epistoma; the thorax—lateral stria fine, ceasing at the anterior angle, basal edge impunctate; the elytra—outer lateral stria complete, inner stria apical and ceasing at the middle; the propygidium with a boss-like excresence on each side on the posterior edge; the pygidium smooth; the prosternum—lobe marginate, rugose, and excavated on either side, leaving a raised portion in the middle which serves as a prolongation of the keel, striæ along the keel widen out a little near the base, joining acutely in front, interspace flat; the mesosternum marginate anteriorly, triangularly produced in the middle, sinuous on either side, marginal stria continued along the metasternum, the latter is without a median tubercle.

Hab. Bahia.

Euclasea tuberculata, sp. n.

Breviter ovata, rufo-brunnea, nitida; prosterno in medio concavo, mesosterno immarginato; metasterno minute tuberculato.

L. $1\frac{1}{4}$ mill.

Shortly oval, smooth, reddish brown, shining; the forehead slightly impressed anteriorly, stria complete and formed as a carina over the eyes; the thorax somewhat oblique before the anterior angle, lateral stria fine, parallel to the sides and well marked, interstice narrow, along the base is a row of punctures clearly and closely set together and uniform in size; the elytra with two complete lateral striæ, fine and carinate, and one short dorsal stria (corresponding apparently to the third of an ordinary Histerid) at the base and evanescent toward the middle; the pygidium smooth; the prosternum—anterior lobe strongly marginate, striæ gradually converging from the base and joining acutely in front, interspace concave, between the striæ and the coxæ there is a sinuous sulcus; the mesosternum obtusely produced, immarginate and microscopically strigose; the metasternum conspicuously sulcate laterally and strigose at the sides like the mesosternum, in the middle, behind the anterior suture, is a very minute tubercle. The tibiæ in this genus are formed somewhat similarly to those in *Eretmotus*.

Hab. Bahia.

Euclasea obliqua, sp. n.

Picea, nitida, perconvexa; pronoto utrinque obliquo; mesosterno obtuse producto, immarginato; metasterno minute tuberculato.

L. $1\frac{1}{3}$ mill.

Piceous, shining, very convex; the forehead angulate in front, with a fine marginal stria; the thorax—sides somewhat oblique, giving the species a less oval form than its allies, lateral stria fine, not continued behind the head, anterior angles feebly bowed, the punctures along the base are smaller and not so closely set as in *E. tuberculata*; the elytra—lateral striæ fine and complete, dorsal striæ absent; the pygidium smooth; the prosternum—anterior lobe margined and minutely strigose, striæ joining but not acutely in front, interspace grooved, lateral sulci inconspicuous; the mesosternum obtusely produced and immarginate; the metasternum marginate like that of *E. tuberculata*, but less deeply, with a minute median tubercle.

Hab. Mexico.

The genus *Euclasea* was founded on a single example in the Godman Collection, and the discovery of three additional species establishes it as one peculiar to the Central-American fauna.

Trypeticus rhinocerus, sp. n.

Elongatus, truncatus, parum convexus, nitidus; rostro robuste producto; fronte triangulariter excavata; thorace bituberculato; propygidio utrinque minute foveolato.

L. 5½ mill.

Elongate, truncate, rather convex, black, shining; the head triangularly excavated between the eyes, excavation deepest in the middle, snout robust and produced into a somewhat obtuse point; the thorax with a well-marked lateral stria which ceases before the anterior angle, anteriorly between the eye and the outer angle there is also a well-marked stria which is a little bent in following the outline of the thorax, immediately behind the neck is a small median carina, and behind the carina, but well before the centre of the thorax, are two small tubercles a little separated from each other, and behind them a fine median line is visible which reaches nearly to the edge before the scutellum, surface sparsely punctulate; the elytra are more densely punctured than the thorax, especially before and at the apices; the propygidium has two small foveæ, one on either side near the base, but not very close to the outer edge; the prosternum truncate before and behind, with a straight lateral sulcus on each side which touches the base, but is slightly abbreviated anteriorly, interspace flat and sparsely punctulate; the mesosternum truncate and immarginate anteriorly, with a lateral crescent-shaped sulcus on each side between the anterior and intermediate coxæ, surface, like that also of the metasternum, is more sparsely punctulate than the prosternum; the tibiæ—anterior and intermediate 5-dentate, posterior setose on the outer edge, with the apices somewhat minutely 3-dentate.

Hab. Andai, New Guinea. One male example.

This species is probably very near *T. Albertisii*, Gestro; but it cannot be the same, I think, although the female only of the last is described.

Trypeticus bifoveolatus, sp. n.

Cylindricus, subrobustus, niger, nitidus: fronte triangulata, margine carinato; thorace antice carina brevi, in medio posteaque tuberculato; pygidio bifoveolato.

L. $4\frac{3}{4}$ mill.

Cylindrical, somewhat robust, black, shining; forehead triangular and feebly uneven, with a few microscopic punctures, margin carinate, straight at the sides, feebly sinuous at the base, apex of the snout emarginate; the thorax carinate laterally, slightly oblique on each side of the head, lateral angles well marked, bisinuous behind the neck, depressed in front, with a median carina touching the anterior margin and leaving a small interspace, a tubercle behind it, punctuation rather sparse and fine; the elytra punctured somewhat like the thorax, but more densely; the last three segments of the abdomen are thickened at the edges and project over the sides; the propygidium is narrow and transverse, distinctly punctate, punctures not very close, on each side (well within the margin) is an ill-defined fovea; the pygidium clearly punctured, but the punctures are larger than on the propygidium, and at the base on either side, just within the margin, is a very distinct fovea; the prosternum is one third longer than broad, truncate behind, slightly widening out before the anterior angles, laterally there is a stria which reaches the base and ceases anteriorly where the prosternum widens; the mesosternum truncate anteriorly and without a true marginal stria, but there are two lateral striæ which join in front well behind the anterior edge somewhat in the form of a gothic arch; the meso- and the metasternum are sparsely punctured. The anterior tibiæ have five or six strong teeth.

Similar to *T. Dohertyi*, Lew., and *T. crassus*, Sch., but as regards the abdominal segments it resembles *T. cinctipygus*, Mars., and *T. prædaceus*, Lew.

Hab. S.E. Borneo, 1000 feet alt. (*Doherty*, 1892).

Teretriosoma afrum, sp. n.

Cylindricum, breve, robustum, nigrum, antennis pedibusque con-

coloribus, tarsis piceis, undique punctatum; propygidio pygidioque ocellato-punctatis; tibiis anticis 5–6-dentatis.
L. $3\frac{1}{3}$ mill.

Cylindrical, short and robust, wholly black; the head convex, evenly not thickly punctured; the thorax little prominent over the neck, rounded off at the sides, punctured like the head in front and on the sides, with an antescutellar impression in which the punctures are larger and closer, the lateral margin is a little raised and the stria within it well marked and a little incurved towards the base; the elytra clearly punctured like the thorax, with the smooth basal margin extremely narrow or obsolete; the propygidium and the pygidium on its convex surface are ocellately punctured, punctures not closely set, the apex of the pygidium is feebly concave and distinctly rugose; the prosternum—anterior edge with a marginal stria, somewhat closely and a little rugosely punctured, base with a triangular impression seen in certain lights, keel without striæ; the mesosternum anteriorly obtusely produced, marginal stria fairly well defined but not clearly joined in front; meso- and metasternal plates sparsely and rather coarsely, except in the central area, punctured; the anterior tibiæ 5–6-, intermediate 5-dentate, posterior 5-spinose; tarsi pitchy red.

Hab. Central Africa (*Nonfried*).

Teretriosoma Hornii, Lew.

The pilosity on the first joint is apparently a male character in the genus. Schmidt first noticed this, and Dr. Horn tells me that two of his specimens of the above species have a hairy first joint and in three of them it is smooth; when the hairs are absent Dr. Horn adds the specimens (presumably female) have the angle of the pygidium less acute. This sexual character should be borne in mind when the females, at present unknown, are discovered of *T. pilicorne*, Lew., and *T. plumicorne*, Lew., and others.

Teretrius australis, sp. n.

Cylindricus, rufo-brunneus, nitidus, undique punctulatus; pronoto angulis anticis prominulis, utrinque sinuato; elytris basi anguste lævibus; prosterno basi impresso, striis antice abbreviatis.
L. 2 mill.

Cylindrical, reddish brown, shining; the head evenly, not thickly punctured, punctures largest near the neck; the thorax—anterior angles depressed and prominent, but markedly rounded off, stria complete, very fine behind the head, sinuous laterally, deep behind the middle, and leaving at this point a widened margin; the elytra punctured like the thorax, narrowly smooth at the base, a little reddish at the humeral angle and narrowly at the apices; the propygidium and pygidium are evenly, not thickly punctured; the prosternum—punctures large and scattered, bistriate, striæ well marked and slightly divergent in front, somewhat wide apart, shortened a little at the base, anteriorly reaching beyond the middle; the mesosternum obtuse, similarly punctured and marginate, margin interrupted at the metasternal suture, the sutural area is free from punctures; the metasternum has a lateral stria for two-thirds its length, which is punctate on its inner edge, the surface has a finely and more scattered punctuation than the mesosternum; anterior tibiæ 5-dentate, intermediate 6-spinose, 1 basal small, 3 strong placed together in the middle and 2 at the apex; the hind coxæ are very peculiar, they are swollen and tuberculate, the base of the tibia being inserted apparently on the apex of a cone.

This species may be placed next to *T. basalis*, Lew., from which it is scarcely separable on the upper surface; but the prosternum in *T. australis* is longer, with the striæ well marked and nearly straight, and the mesosternum is obtuse anteriorly. In *T. basalis* the mesosternum is somewhat acute, and there is no peculiarity in the coxæ.

Hab. Queensland (*Simson*). Coll. Fry.

Acritus Lightfooti, sp. n.

Ovalis, convexus, brunneus, nitidus; antennis pedibusque concoloribus; elytris antice punctatis, postice conspicue strigosis; pygidio dense et minutissime punctulato; prosterno bistriato, striis rectis divaricatis, basi conjunctis.

L. $1\frac{1}{2}$, c. $1\frac{3}{4}$ mill.

Oval, convex, brown, shining; the head even between the eyes, feebly and sparsely punctulate, epistoma rugosely punctate; the thorax—marginal stria complete in front and at the sides, punctuation shallow, not close, finest before the scutellum; the scutellum smooth and obvious; the elytra—around the scutellum and a little part down the suture the punctuation is very fine and sparse, on the dorsal area and sides it is larger, but similar to that of the thorax, with a dense and conspicuous strigose sculpture at the apex, which extends up the elytra for nearly one third of their length, gradually giving way to the punctures; the propygidium and pygidium are densely covered with a microscopic punctuation, the latter having a few large punctures on its edge near the base; the prosternum—keel smooth and bistriate, striæ joining rectangularly at the base, thence gradually widening out to the anterior suture and there terminating; the mesosternum obtusely produced in front, marginal stria complete, and with the metasternum and first abdominal segment sculptured with large shallow punctures not closely set.

Hab. Cape Town, January 1891 (*R. M. Lightfoot*).

LXIX.—*On new and little-known* Tessaratominæ *of the Order Rhynchota.* By W. L. DISTANT.

Lyramorpha picta, sp. n.

Head, pronotum, scutellum, body beneath, and legs pale olivaceous; the posterior area of the pronotum and the apical third of the scutellum dark olivaceous. Corium purplish brown, with a large pitchy-black spot a little before apex, extreme costal margin pale olivaceous or ochraceous; membrane cupreous. Antennæ brownish ochraceous; apex of the first joint, upper surface of the second, apex of the third, and the whole of the fourth and fifth joints (excluding their bases) fuscous; the fourth and fifth joints subequal in length and longer than the second joint. Eyes, coxal spots, apex of rostrum, and the apices of the apical abdominal segments fuscous. The body above is very obscurely and finely punctate, excepting on the apical area of the scutellum, where the punctures are larger and more distinct; the pronotum and scutellum are finely subrugulose.

Long. 21 millim.

Hab. Malayan Archipelago; Batchian.

The dark hue and markings of this species will at once distinguish it from all the other species of the genus excepting the *L. ramifera*, Walk., described from New Guinea; but the spotted corium of *L. picta* will prevent any confusion.

Embolosterna taurus.

Tesseratoma taurus, Hope, Cat. Hem. i. p. 27 (1837).

In some specimens collected by Mr. Whitehead on the Kina Balu mountain in Borneo the pronotal angles are considerably more developed than in the Malaccan examples of my own collection, which may be considered the typical form of the species. As the Bornean specimens, however, are not constant in that respect, the length of the pronotal angles in this species may be regarded as of a varietal character.

Tessaratoma absimilis, sp. n.

Head, pronotum, scutellum, body beneath, and legs greenish ochraceous; corium brownish ochraceous; membrane cupreous; antennæ ochraceous, second joint slightly longer than either third or fourth joints, which are subequal in length. Sternal keel reaching the anterior coxæ and olivaceous in hue. Pronotum with the lateral margin oblique, not dilated, and only very slightly convex. Body slender.

Long. 22 millim.; lat. pronot. angl. 10½ millim.

Hab. East Africa; Mpwapwa.

This species is distinguished by the non-dilated and oblique lateral margins to the pronotum, the slender body, &c.

Pygoplatys tauriformis, sp. n.

Pale olivaceous, obscurely punctate; pronotal angles strongly produced in long anteriorly curved spines, marked with very coarse black punctures and with their apices subacute and slightly recurved. Antennæ castaneous, the apical joint (excluding apex) fuscous. Eyes, apices of the tibiæ, the tarsi, and lateral and apical margins of the abdomen (narrowly) black, the last also spotted with ochraceous.

Long. 21 millim.; exp. pronot. angl. 20 millim.

Hab. Tenasserim valley; Myitta.

Allied to *P. trucidus*, Walk., but with the pronotal angles much more produced and curved outwardly.

Pygoplatys lunatus, sp. n.

Brownish ochraceous; basal area of head black. Pronotum with the anterior area and the pronotal angles with very coarse black punctures, posterior area of the pronotum much more obscurely punctate; lateral pronotal angles produced in long forwardly-curved spines, with their apices subacute. Scutellum sparsely and finely punctate, the apical area profoundly and longitudinally sulcated. Corium very finely and thickly punctate. Membrane cupreous. Abdominal spiracles fuscous. Antennæ pale fuscous, with the apical joint ochraceous.

Long. 20–23 millim.; lat. pronot. angl. 16–17 millim.

Hab. Borneo; Sandakan.

This species, by the structure of the pronotal angles, is allied to *P. tauriformis* described above; it differs, however, not only in the uniform brownish-ochraceous hue, but also in having the head and pronotum longer and the apex of the scutellum more deeply sulcate. It is also apparently allied to the Philippine species *P. bovillus*, Stål; but the different punctuation of the pronotum, and the colour of the head, antennæ, &c. are sufficient to distinguish it from the description of that species.

Pygoplatys firmatus.

Piezosternum firmatum, Walk. Cat. Het. iii. p. 458. n. 5 (1868).

Long. 17 millim.; lat. pronot. angl. 13 millim.

The type was from Malacca. I possess a specimen from the adjoining province of Perak.

Pygoplatys cribratus.

Piezosternum cribratum, Walk. Cat. Het. iii. p. 458. n. 6 (1868).

Long. 14 millim.; lat. pronot. angl. 13 millim.
Hab. Malacca. Brit. Mus.

Pygoplatys ingenus.

Piezosternum ingenum, Walk. Cat. Het. iii. p. 459. n. 7 (1868).

Long. 19 millim.; lat. pronot. angl. 13 millim.
Hab. ——? Brit. Mus.

Pygoplatys forticornis.

Tesseratoma forticornis, Walk. Cat. Het. iii. p. 465. n. 23 (1868).

Long. 21 millim.; lat. pronot. angl. 16 millim.
Hab. Borneo; Sarawak. Brit. Mus.

Mattiphus jaspideus.

Pycanum jaspideum, H.-S. Wanz. Ins. ix. p. 308, fig. 1009 (1853); Stål, En. Hem. i. p. 75. n. 4 (1870).

I now possess several examples of this species from Assam, the habitat from which it was described. It belongs to the genus *Mattiphus*. All my specimens are broader than the one figured by Herrich-Schäffer, and the beautifully bright coloration is seldom retained, though one of my specimens is perfect in that respect and exactly resembles the figure. Stål had not seen, but only recorded the species.

ORIGANAUS, gen. nov.

Body moderately elongate and narrowed towards apex.

Head about as long as wide at base (including the eyes). Rostrum slightly passing the anterior coxæ. Antennæ with the basal joint not quite reaching the apex of the head, second joint considerably longer than the third (remainder mutilated). Pronotum laterally and angularly dilated. Abdomen with the apices of the apical segment moderately and angularly produced, but not reaching the apex of the anal appendage. Prosternum with a flat central oval elevation, which is somewhat broadly sulcated towards the anterior coxæ. Metasternum with a broad, central, flat elevation, reaching the intermediate coxæ and narrowed and rounded in front. Posterior tibiæ slightly curved at base. Membrane with three prominent cells on basal margin, the veins numerous and longitudinal.

This genus is allied to *Mattiphus* and *Asiarcha*, from both of which it differs in the characters of the sternal elevations &c.

Origanaus humerosus, sp. n.

Very dark purplish brown; eyes, legs, and body beneath ochraceous or pale castaneous (in fresh specimens the body beneath is evidently pale resplendent green). Pronotal angles broadly and subtruncately produced; from their apices the lateral margins are moderately concave. Membrane pale cupreous. Abdomen above purplish red, with two central metallic greenish fasciæ and the lateral and apical margins dark purplish brown. Pronotum and scutellum finely transversely rugulose; corium very thickly and finely punctate. Connexivum nearly black, spotted with ochraceous at the bases of the segments.

Long. 20–24 millim.; lat. pronot. angl. 12–14 millim.

Hab. Continental India; Naga Hills.

Although I possess six specimens of this species, perfect antennæ is unfortunately not a character of any of them.

Pycanum ochraceum, sp. n.

Pale uniform ochraceous; antennæ black, with the basal joint and extreme apex of the fourth joint ochraceous. Lateral margins of the head black. Pronotum with the lateral margins moderately ampliated and rounded, as in *P. rubens*, Fabr. Scutellum with the apical margin stramineous. Membrane aurichalceous. Connexivum spotted with stramineous at the bases of the segments. Body beneath resplendent violaceous or greenish with a longitudinal central fascia, the lateral margins, sternal margins, and sternal curved fasciæ on each side and the legs ochraceous. Femoral apical spines blackish. Abdomen above bluish black, with two broken, narrow, central longitudinal fasciæ.

Long. 24–28 millim.

Hab. Continental India; Darjeeling, Naga and Khasia Hills.

This species is allied to *P. rubens*, and apparently replaces it in continental India. It is to be known by the pale uniform ochraceous coloration, the colour of the abdomen above, the markings of the connexivum (in which the pale spots are much the smallest), &c.

In 1879 (Ann. & Mag. Nat. Hist. ser. 5, vol. iii. p. 52) I enumerated specimens of this species as a variety of *P. rubens*. Since then, however, I have received large series from different localities in North-east India, and by a closer study have discovered other differences besides the distinctive coloration of the upper surface.

Pycanum rubidum, Walk. Cat. Het. iii. p. 471. n. 11 (1868), =*Pycanum pretiosum*, Stål, Œfv. Vet.-Ak. Förh. 1854, p. 234. n. 2.

Pycanum stabile, Walk. Cat. Het. iii. p. 472. n. 12 (1868).

Should be placed in the genus *Carpona*. In the type the posterior legs are mutilated, but it seems to clearly belong to Dohrn's genus.

Pycanum pallipes, Walk. Cat. Het. iii. p. 473. n. 14 (1868), =*Mattiphus oblongus*, Dall. List Hem. i. p. 344. n. 1 (1851).

Division CYCLOGASTRINA (Stål).

GARCEUS, gen. nov.

Body flat, ovate. Antennæ moderately robust, finely setose, four-jointed; basal joint stoutest, not reaching the apex of the head, second joint longest. Head with an obtuse spine in front of the eyes, sinuate and narrowed to apex, central lobe very short, about half the length of head. Pronotum with the anterior margin deeply concave, the lateral margins laminate and convexly rounded, the posterior angles sinuately oblique, basal margin sinuate. Scutellum about half the length of the body, its apex moderately broad. Corium with the base of the lateral margins laminate, the apical margin sinuate. Membrane not quite reaching the apex of the body, the venation longitudinal. Abdomen with the lateral margins produced and convex. Rostrum just passing the anterior coxæ. Mesosternum wide; a transverse elevation between the intermediate and posterior coxæ, which are situate close together. Abdomen beneath very flat and depressed. Legs finely setose.

This is the first Australian genus of this division of the Tessaratominæ with which I am acquainted.

Garceus fidelis, sp. n.

Pale uniform ochraceous. Antennæ with the first and third joints subequal in length, second joint longest. Pronotum and scutellum with an obscure central longitudinal carination; pronotum with a distinct fovea on each side of the anterior area, the lateral margins laminately ampliated and slightly recurved; the whole disk obscurely transversely wrinkled. Scutellum and corium thickly, obscurely, and finely punctate.

Long. 16 millim.; lat. pronot. angl. 8 millim.; max. lat. abd. 10 millim.

Hab. Australia; Peak Downs, in Queensland.

LXX.—*The Range of* Placostylus: *a Study in Ancient Geography*. By C. Hedley, F.L.S.*

The genus *Placostylus* appears a more fruitful subject of study than any other molluscan genus inhabiting the same area. Their large and handsome shells have attracted the attention of the most superficial and unscientific collectors; as a result an extensive series of them have been brought to our knowledge from remote localities. Close and attentive scrutiny would scarcely justify an observer in declaring that a particular minute shell did not inhabit any given island, whereas a casual survey would decide whether a conspicuous shell like *Placostylus* did or did not compose a portion of that island's fauna. A larger mass of evidence, both negative and positive, is therefore at our disposal in dealing with *Placostylus* than awaits us in studying smaller species.

The genus ranges from Faro Island, Solomons (*P. founaki*), in the north, to Whangarei, New Zealand (*P. bovinus*), in

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* From the 'Proceedings of the Linnean Society of New South Wales,' August 31, 1892. Communicated by the Author.

the south, and from Lanthala, Fijis (*P. morosus*), in the east, to Lord Howe Island (*P. bivaricosus*) in the west; and, so far as is yet known, is distributed as follows:—New Caledonia, 34; Solomons, 16; New Hebrides, 3; Fiji, 16; New Zealand, 1; Lord Howe, 1. The area of distribution of *Placostylus* corresponds generally to that great arc of volcanic activity which stretches across the south-west Pacific from the Solomons through the New Hebrides to New Zealand. On either side of this earth-wave extend banks to New Caledonia, Fiji, and Lord Howe, indented by abyssal gulfs. This plateau, which for want of a better name I will call the MELANESIAN PLATEAU, is probably circumscribed by the 1300-fathom zone, and probably the various archipelagoes upon it are connected by comparatively shallow banks; but the fragmentary knowledge we yet possess of the contour of the floor of the South Pacific does not enable us to trace its margin.

Eastwards of Fiji the molluscan fauna indicates the abrupt termination of the Melanesian Plateau. Between the Samoas and Fijis a sounding of 2600 fathoms has been obtained. Significant of this is the absence of *Placostylus* from Savaii, Upolu, or Tutuila. The Samoan Islands appear as well fitted as the Fijian to nourish an extensive series of *Placostylus*. They are large, densely wooded, with a warm, moist, and equable climate. The distance from their western neighbours is no greater than from the latter to the groups to the westward, and not to be compared to the spaces between New Caledonia and Lord Howe or New Zealand, which have proved no obstacle to the spread of the genus. Yet the Samoas possess a distinctly oceanic mollusk fauna comparable to that of Tahiti, while the mollusk fauna of the Fijis is as distinctly continental.

On the westward we learn from the 'Challenger' soundings that about the 20th parallel a bank of a maximum depth of 1300 fathoms connects the Melanesian Plateau with the Great Barrier Reef. This bank was not actually plumbed, but its existence is inferred from the fact that soundings in the Coral Sea diminished in temperature down to 1300 fathoms, and below that level to 2450 fathoms the thermometer readings were stationary. The inrush of cold water from the Antarctic abyss is therefore stopped by banks, whose lowest depth is 1300 fathoms, hemming in the abyss of the Coral Sea. But the canal whose floor is the 1300-fathom level MAY lie, not between the Great Barrier Reef and New Caledonia, but at the head of the gulf between the Loyalties and the New Hebrides.

Wallace, in his 'Island Life,' advances the theory* that Australia and New Zealand were formerly connected by a bridge of dry land occupying somewhat the position of the Caledonian-Barrier bank. This theory is totally opposed to the distribution of the *Placostylus* in particular and of the Melanesian mollusk fauna in general. Were it true, then Lord Howe, the furthest western outpost of the Melanesian Plateau, would be tenanted by forms bearing some resemblance to Queensland Mollusca. Had the stream of life reached Lord Howe from the north-west instead of from the north-east, then *Placostylus* would have been replaced by *Hadra* and *Chloritis*, while *Pupina* and *Helicina* would have been substituted for *Realia* and *Omphalotropis*.

The various islands inhabited by *Placostylus* would seem to have been joined, if not into one continuous and contemporaneous whole, yet into larger fragments, which, temporarily united, allowed the passage of snails from one tract to another. Should it be proved that the islands occupied by *Placostylus* are now sundered by deeper channels than that between Australia and the Melanesian Plateau, even that would not defeat the argument of their former union and of their eternal separation from Australia. Not the depth but the permanence of the ocean is the real limit to the distribution of forms of life. The geology of the Solomon-New-Zealand arc, imperfectly as it is yet read, shows a most tempestuous record of lands now sunk in the stillest ocean-deeps and anon flung into lofty mountain ranges. The history of the north-east Australian coast exhibits no such vicissitudes, but it appears to have retained its present outline for long ages past. The channel joining the abysses of the Coral and of the Tasman Seas would therefore be more permanent than channels, possibly deeper, intersecting the Melanesian Plateau.

The genus *Placostylus* divides itself naturally into halves. The southern portion are inhabitants of New Caledonia, Lord Howe, and New Zealand. Almost all are heavy massive shells, dark in colour, confined to the ground by the mere weight of the shell, and singularly unfitted to cross distant seas by any means that I can imagine. The northern portion are usually tree-dwellers, the shell of a light structure and sometimes brilliantly coloured. Between New Zealand

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* "Confining ourselves strictly to the direct relations between the plants of New Zealand and of Australia . . . . . I think I may claim to have shown that the union between the two countries in the latter part of the Secondary epoch . . . . does sufficiently account for all the main features of the New Zealand flora" (2nd ed. p. 506).

and Fiji a line of soundings has been recorded of over 2000 fathoms, while between New Caledonia and the New Hebrides two soundings of 2650 and of 2525 fathoms would indicate that a gulf running south-east from the Coral Sea here intervenes. The differences between the northern and southern types of *Placostylus* are supplemented by other features of their respective mollusk faunas. The northern type is everywhere accompanied by *Trochomorpha*, which is never associated with the southern. Species of the so-called *Melanopsis* occur in New Zealand and in New Caledonia, but are unknown in the northern archipelagoes. These scanty data appear to show that early in the history of the existing fauna the Melanesian Plateau was rent in twain and has never since been united.

The forms of *Placostylus* inhabiting the Fijis resemble in shape and colour sundry of the Solomon-Island species. Thus *elobatus* from Levuka and *christovalensis* from San Christoval are much alike both in shape and colour-pattern, and *Seemanni* from Kandavu finds a close parallel in *Macfarlandi* from the Solomons. The remainder of the land-mollusca of each archipelago contribute further evidence of affinity; thus *Nanina nitidissima* from the Solomons resembles *N. casca* from Fiji; both areas also possess a *Pupina*. Such affinity would warrant the deduction that the Solomons were the source of the Fijian molluscan fauna, though the former group had probably not then received from Papua the newer genera of *Chloritis* and *Papuina*. Eastwards from the Melanesian Plateau *Placostylus* was unable to extend its range; but its derivative and representative *Partula*, together with other Melanesian emigrants, *Endodonta*, *Tornatellina*, *Helicina*, and similar minute forms, drifting eastwards from island to island, colonized the oceanic groups of the south-east Pacific.

Summary.—I would remark, firstly, on the essential unity of the *Placostylus* area as a zoological province, embracing the archipelagoes of Solomon, Fiji, New Hebrides, Loyalty, New Caledonia, Norfolk Island (?), Lord Howe, and New Zealand—a unity explicable only on the theory that they form portions of a shattered continent and are connected by shallow banks, formerly dry land. This continental area I propose to call the Melanesian Plateau. Secondly, that this Melanesian Plateau was never connected with nor populated from Australia; probably its fauna was derived from Papua, *viâ* New Britain. The presence of genera common to Australia and New Zealand is explicable on the ground that they migrated, not from the one territory to the other, but each from a common source, New Guinea. Thirdly, that New Zealand and New Caledonia were early separated from the northern archipelagoes, and ceased to receive overland immigrants therefrom. Fourthly, that the Fijis remained to a later date in communication with the Solomons, but were severed from that group before the latter had acquired from Papua much of its present fauna.

LXXI.—*Note on* Mesoplodon bidens.

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

GENTLEMEN,—Although I do not pretend to have any special knowledge of Cetacea, I think it might prove of some interest to your readers, and also serve to complete the account given in the April number of your Journal of this extremely rare whale, if I draw attention to a fact which has come to light since the skeleton of the fœtus described has been macerated.

In Messrs. Southwell and Harmer's account of *Mesoplodon bidens* the authors say that while several of the older drawings and descriptions give the colour of the ventral surface as white, in the fine adult female I now possess the whole ventral surface is black.

Now in the mandible of the fœtus the two teeth characteristic of the male are much developed and nearly 1½ inch long, which seems to prove this fœtus to have been of the male sex. In the fœtus the under surface, although much suffused with blood, clearly was white; this, I think, tends to prove that the male *Mesoplodon bidens* has the ventral surface white, while the female, apart from the white spots on the back, is uniformly dark on both *ventral and dorsal surfaces.*

I remain, Gentlemen,
Yours faithfully,
WALTER ROTHSCHILD.

LXXII.—*A Contribution to the Knowledge of the Genealogy and Classification of the Crustacea.* By Prof. KARL GROBBEN, of Vienna[*].

A CONSTANT attraction towards fresh consideration in respect of phylogeny is exerted by the Crustacea, a class presenting a variety of form and withal sharply defined, and which in Fritz Müller's treatise 'Für Darwin' (Leipzig, 1864), which has become famous, first served as a test of the correctness of the Darwinian theory. It was to such a consideration that I subjected the group on the basis of ideas which I have pursued for a number of years.

As the starting-point for my reflections I availed myself of the striking fact, as to which doubts have been expressed in isolated cases only[†], that the large Phyllopods, which I shall henceforth designate as Euphyllopoda, and which among existing Crustacea come nearest to the ancestral forms of which they may be regarded as remnants, are represented by three types. These are *Branchipus*, *Apus*, and *Estheria*, which, while agreeing in all essential structural characters, differ very widely one from another in outward appearance as a whole, as well as in the special form of the several parts of their bodies.

On the other hand, it struck me that among the Euphyllopoda certain points of agreement with the Malacostraca are especially exhibited by *Branchipus*, while the type of which

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[*] Translated from the 'Sitzungsberichte der kaiserlichen Akademie der Wissenschaften.—Mathematisch-naturwissenschaftliche Classe,' ci. Bd. ii. Heft, Jahrg. 1892, Abth. i. pp. 237-274: Wien, 1892.

[†] Thus it is considered by A. S. Packard that the large Phyllopods are a highly developed and extremely specialized branch of the Cladoceran stem, which is further connected by means of the Ostracods with the Copepods, from which it must be held to have been derived ('A Monograph of the North-American Phyllopod Crustacea,' United States Geological and Geographical Survey, Washington, 1883, pp. 417, 419, and 448).

Moreover, G. O. Sars ('Report on the Phyllocarida collected by H.M.S. 'Challenger' during the years 1873-76,' Zoology, vol. xix., 1887) regards the Copepods as the most primitive of recent Crustacea, and derives the Branchiopods from Copepod-like ancestors. In a similar manner Hartog ("The Morphology of *Cyclops* and the Relations of the Copepoda," Trans. Linn. Soc. Lond. ser. ii. Zoology, vol. v., 1888) considers the Copepods to be a primitive type and the ancestral form of the Crustacea. It was not until a later stage in the series that, according to Hartog, the Protophyllopods were derived from a Copepod-like ancestral form of this kind; the Protophyllopods on their part gave rise on the one hand to the Phyllopods, and on the other, through the Nebaliids, to the Arthrostraca and Thoracostraca.

Apus is an example is to be found in the Copepoda and in their allies the Cirripedia; and that the Ostracoda in many respects exhibit characters of *Estheria*, not to speak of the Cladocera, whose close affinity to *Estheria* will not be disputed.

In addition to this there came the conviction that the present grouping together of the lower Crustacea as Entomostraca, as opposed to the Malacostraca, does not betoken a natural arrangement.

All these points led me to inquire whether, as a matter of fact, *Branchipus* ought not to be regarded as a remnant of the Archi-Phyllopod series, from which the Malacostraca have sprung, while a similar remnant is represented by *Apus* in the case of Copepods and Cirripedes, and by *Estheria* in that of the Ostracoda, and at all events in all probability of the Cladocera; and whether, in the event of an affirmative answer to this question, an attempt should not be made to establish a more natural system of classification among the Crustacea composing the group Entomostraca.

In discussing this question we shall in the first place have to compare one with another the three Euphyllopod types above mentioned, as well as the peculiarities of the different Crustacean orders. For the purposes of such a consideration it will suffice to institute a comparison between merely the most primitive forms in each individual order.

As regards the structure of the Crustacea material is available in abundance in the shape of a voluminous literature, which, however, I do not intend to quote in full in this paper; in the present communication only a certain number of publications will be cited, and in the first instance such as demand closer consideration with reference to my views.

THE EUPHYLLOPODA.

Among the Euphyllopoda the *Branchipus*-type appears to be the most primitive, although again many of its peculiarities must be regarded as having been secondarily acquired. Among the primitive characters must be mentioned the elongated form of the body, the fin-like development of the furca, which is beset with setæ along its entire margin, the situation of the eyes upon stalks, the similar development and the form of the thoracic appendages, and the prolongation of the heart throughout the whole of the body-segments; on the other hand, a secondary character is seen in the absence of a shell, which originally must also have been present in the ancestors of *Branchipus*; of a secondary nature again is the smaller number (20)* of the segments of the body as compared with what we find in *Apus* and *Estheria*, the sharp separation between the thoracic and the abdominal region, the latter of which is devoid of appendages in the adult, and the modification of the second antenna into a lamelliform structure in the female and into an apparatus of considerable size in the male. By the absence of the shell, the elongated form of the body, the powerful development of the musculature of the trunk, which comes into action in the darting motion of the body, and the not very large number of segments in the thorax and abdomen, *Branchipus* is characterized among the Euphyllopoda as the form best adapted to the movement of swimming.

On comparing *Apus* with *Branchipus* the first point which will have to be noticed as a primitive character in the case of the former is the larger number (33) † of the segments of the body. In *Apus*, too, the transition from the thorax to the limbless abdomen appears to be a more gradual one, owing to the fact that there is a continuous and very striking diminution in the size of the thoracic appendages towards the rear. As a peculiarity which is found in *Apus* alone among the Euphyllopoda must be mentioned the large number (63) of the thoracic appendages; the eleven anterior segments of the body each bear one pair of appendages (they correspond to the eleven limb-bearing thoracic segments of *Branchipus*), while upon the following seventeen segments we find a larger and posteriorly increasing number of limbs, so that to the last two limb-bearing segments there together belong twelve pairs of appendages. I will not here attempt to decide whether in the posterior section of the thorax of *Apus* we have to deal with a fusion of several segments to form larger annuli, or with a multiplication of the appendages within the segments, although I rather incline to the latter view. In any case, whether concentration of segments or multiplication of the appendages has taken place, it would be a question of a secondary condition.

Thus, should the actual number of the body-segments be determined by the number of the appendages, the segmentation of the body, in this case unusually extensive, would surely have to be regarded as a secondary character.

Apus bears a small shield-shaped shell covering the anterior segments of the thorax, and herein possesses, as opposed to *Branchipus*, an old character belonging to the common

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* Among the Branchipodidæ the genus *Polyartemia* alone possesses a larger number of segments (namely 22), nineteen of which bear appendages.

† The numbers refer to *Apus cancriformis*.

ancestral form. The lateral margins of the shell in *Apus* are directly continuous with the anterior border of the head, a peculiarity to which we shall have to revert later on. Divergence from the original ancestral form is seen in the special development of the thoracic appendages. As opposed to *Branchipus*, in which the appendage is expanded like a leaf, we find in *Apus* a narrow elongated axis and an elongated stiff form of endites, the most distal of which (the sixth) corresponds to the endopodite*. It is true that this elongated form is in the first instance assumed only by the anterior appendages, while the posterior ones are very broad. Yet in my opinion the anterior limbs of *Apus* (although not exactly the two first, which have undergone further modification) exhibit the more primitive form with reference to the shape of the larval limbs, and also with regard to the form of the appendages which must be assumed for the ancestral types.

The furcal appendages in *Apus* are elongated and developed into the shape of filaments. As a secondary character must be regarded the total loss or the far-reaching degeneration of the second antenna, the original function of which as a swimming-foot has been taken over by the first thoracic appendage, which is furnished with long flagelliform processes. The heart does not extend, as in *Branchipus*, throughout the whole of the segments of the body, but is confined to the anterior half of the trunk, a phenomenon which, when contrasted with the primitive condition met with in *Branchipus*, must be regarded as of a secondary nature. In a similar fashion is to be interpreted the displacement of the compound eye in *Apus*. The two eyes are not situated upon stalks, but, as I have previously shown †, are sunken and covered by a reduplicature of the skin; at the same time they are closely approximated to the median line.

A type which in general appearance diverges very widely from *Branchipus* as well as from *Apus* is constituted by *Estheria*. In this case the body is thickset and laterally

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* I am unable to assent to the interpretation given by Ray Lankester ("Observations and Reflections on the Appendages and on the Nervous System of *Apus cancriformis*," Quart. Journ. Micr. Sci. vol. xxi., 1881, p. 363) of the sixth endite as the exopodite, and of the fifth as the endopodite, since the facts of embryology go to show that the sixth endite corresponds to the endopodite and the flabellum to the exopodite.—*Cf.* C. Claus, "Zur Kenntniss des Baues und der Entwicklung von *Branchipus stagnalis* und *Apus cancriformis*," Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen, xviii. Bd., 1873, p. 20.

† *Cf.* C. Grobben, "Die Entwicklungsgeschichte der *Moina rectirostris*. Zugleich ein Beitrag zur Kenntniss der Anatomie der Phyllopoden," Arbeiten des zoolog. Institutes zu Wien, Bd. ii., 1879, pp. 51 *et seq.*

compressed, while together with the head it is completely covered by the ample bivalve shell, which is closed by a muscle. The number of the segments of the body is larger than in *Branchipus* (amounting to as many as 28), and the elongate lamelliform appendages appear on all the free thoracic segments, gradually diminishing in size towards the rear. The end of the abdomen exhibits a very peculiar development and is seen to be bent towards the ventral surface and cleft into two lamellæ, which are armed at the end with hook-shaped furcal branches. A decidedly ancient character is to be observed in the second antenna, which has retained the shape of a swimming-foot. The heart remains still shorter than in *Apus*, and merely extends through the foremost portion of the body. The two compound eyes are in complete contact one with another in the median line; at the same time, just as in the case of *Apus*, they are sunken and overgrown by a reduplicature of the skin. While, however, in the case of *Apus* the eyes are driven to the dorsal side, in consequence of the lateral extension of the carapace and the inclusion of the head in its prolongation, we find them in *Estheria* enclosed in the narrow head, above and beyond which lie the valves of the shell. The peculiar position of the two eyes, as well as their convergence in the median plane, is occasioned by the formation of the shell, as has already been explained by Dohrn [*]. In consequence of the inclusion of the body between the valves of the shell and the lateral compression connected therewith the original eye-stalks degenerated and the eyes were pressed together in the median line. The opacity of the shell favoured this process. The overgrowth of the fused eyes by the skin may have developed as a protection for the visual organ in connexion with the burrowing mode of life of *Estheria*, just as the same cause probably cooperated in the case of *Apus* also. It is probable that the overgrowth and approximation of the eyes in *Apus* and *Estheria* arose independently in the two groups.

As a secondary character which is common to all three Euphyllopod types must be mentioned the degeneration of the mandibular palp and the reduction of both pairs of maxillæ.

The peculiar development of the furca and the relative heaviness of the valves of the shell are a sufficient indication that *Estheria* is a form which is well adapted for motion on firm ground, just as moreover, as a matter of fact, this animal

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[*] A. Dohrn, "Geschichte des Krebstammes," Jenaische Zeitschrift für Medicin und Naturwissenschaften, Bd. vi., 1871, p. 149.

readily burrows in mud. In this respect among the three typical Euphyllopods it differs most widely from *Branchipus*, which appears to be the best swimmer of the group. *Apus* occupies about the middle position; it is a good swimmer, but is also fond of remaining at the bottom, where it digs up the mud with its shield *.

THE CLADOCERA.

On considering the structure of the Cladocera we shall be struck by their great agreement with *Estheria*, while a comparison with *Apus* or *Branchipus* cannot be sustained in the same manner. A full idea of the far-reaching similarity between the two first-mentioned forms is acquired, however, when we select for comparison a young *Estheria* at a stage in which some six thoracic feet are present. A stage such as this was described by Joly †, by Ficker ‡, and likewise by Claus §, while by the latter it was also employed for the purpose of a searching comparison with the Cladocera, in the sense of the closest original relationship. An appeal to the existing statements on the subject will here suffice, and I will merely refer to the most important points of agreement.

In the Cladocera, just as in the case of *Estheria*, the body is laterally compressed. The shell is bivalve and covers the entire body, with the exception, however, of the head, which remains uncovered. The furcal end of the abdomen exhibits the development which is found only in the *Estheria*-type among the Euphyllopoda; as in the case of *Estheria*, it is bent towards the ventral surface and is furnished at its extremity with backwardly-directed hooks. The development of the second antenna as a swimming-organ is common to both the Cladocera and *Estheria*. Similarly the absence of the mandibular palp as well as the reduction of the two pairs of maxillæ, of which the second is entirely wanting in the Cladocera, has been inherited from the Euphyllopoda, in this case from *Estheria*. The shape of the thoracic feet can likewise be derived from that of those of *Estheria*, and the more

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* For the statements as to these biological conditions I am indebted to Prof. Brauer. *Cf.* also Bronn's "Classen und Ordnungen des Thierreiches," *Arthropoda*, bearbeitet von A. Gerstaecker. I. *Crustacea*. Erste Hälfte, pp. 1049 *et seq.*

† N. Joly, "Recherches zoologiques, anatomiques et physiologiques sur l'*Isaura cycladoides*," Ann. Sc. Nat. 2^e sér. t. xvii., 1842, p. 325.

‡ G. Ficker, "Zur Kenntniss der Entwicklung von *Estheria ticinensis*," Sitzungsber. k. Akad. Wiss. Wien, math.-naturw. Classe, Bd. 74, 1876.

§ C. Claus, 'Untersuchungen zur Erforschung der genealogischen Grundlage des Crustaceensystems,' Wien, 1876, p. 101.

elongated form of the foliaceous foot is rediscoverable among the Cladocera in genera such as *Sida*, which in all characteristics prove to be the most primitive. Lastly, mention must be made of the compound eyes, which, as in *Estheria*, meet together in the median plane to form a double eye, and, as in the genus referred to, are surrounded by a reduplicature of the skin, with the slight difference that the chamber which is formed above the eye by the overgrowth is in the case of the Cladocera completely closed *.

Claus has also suggested the two possibilities that the Cladocera are to be derived from larval forms of the Estheridæ or from a common ancestor with the latter, without, however, pursuing this question further. The passage referred to in Claus runs as follows:—" For my part there is no question of the fact that they [namely the Cladocera] are to be brought into closer relationship with the larval forms of the Estheridæ, and are to be derived, if not from these, at any rate from a common older ancestral form."

In my opinion this question may be answered with some degree of certainty by the theory that the Cladocera are to be derived from young stages of the Estheridæ.

The reasons to be adduced in favour of this are the following. In the first place the small number of body-segments in the Cladocera, a character which cannot be regarded as a primitive one, since extensive segmentation of the body must be assumed to have existed in old forms of Annulosa, and in the present case is easily to be proved by the fact that the forms *Branchipus* and *Apus* allied to *Estheria*, which is so close to the Cladocera, exhibit the same peculiarity †. Con-

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* Grobben, *loc. cit.*

† There is probably no need to make especial mention of the fact that the number of the body-segments in the Euphyllopods is usually not so great as to necessitate our thinking of a *secondary multiplication of the body-segments*, of which instances are indeed found in the animal kingdom. The large number of appendages in the case of *Apus* is, in my opinion, to be explained by the theory that the appendages themselves have multiplied within the limits of the segment. But should the number of the appendages of this form actually correspond with the number of the body-segments which have coalesced to form a few larger annuli, the large number of body-segments which in this case we should have to recognize in *Apus* would have to be regarded as having been secondarily augmented. I would add merely incidentally that I cannot accept the multiplication of the ventral ganglia in *Apus*, which keeps pace with the increase in the number of the legs, as a proof that the body-rings of *Apus* are to be regarded as complexes of metameres.

But also supposing that the body-rings of *Apus* determine the number of the metameres, with regard to the increase in this number in many species of *Apus* (*e. g.* to about 45 in *Apus Lucasanus*, Pack.), a secondary multiplication of the body-segments would have to be taken into consideration, at least in the case of the more richly segmented species.

sequently the abundant segmentation of the body of *Estheria* appears to be a primitive condition, and likewise the diminished number of body-segments in the other Estheridæ, *Limnadia* and *Limnetis*, when viewed from this standpoint, is seen to be of a secondary nature. If therefore the Estheridæ distinguished by a smaller number of body-segments (*Limnadia* and *Limnetis*), and the Cladocera are to be derived from more richly segmented forms, the process must be imagined to have taken place in such a way that developmental stages of *Estheria* with a smaller number of segments constituted the starting-point for the other Estheridæ, which are composed of fewer segments, and likewise for the Cladocera.

A further argument in favour of the theory that the relatively unwieldy *Estheria* was the ancestor of the Cladocera is furnished by the peculiar shape of the end of the furca, which is adapted for motion on the bottom. If we consider the mode of life of the Cladocera we must designate it as pelagic. The Cladocera move about in the water with a hopping motion. It is true that there are also forms which live in the mud, like certain Linceids (*Monospilus*), but these are not representatives of primitive Cladocera. As such must be regarded the Sididæ, which live in clear water. Now, since the furca of the Cladoceran body points, by reason of its shape, to a mode of life upon the bottom, such as we actually see in the case of *Estheria*, the occurrence of such a furca in the case of the Cladocera is intelligible only if we derive them from forms living upon the bottom. Such a mode of life is, however, usually combined with a larger and heavier body; from this there results a further reason for deriving the Cladocera from an ancestral form distinguished by such characteristics, and for regarding them as Crustacea of the *Estheria*-type which have become adapted to the pelagic mode of life, in consequence of which their development has been arrested at a certain point.

A third piece of evidence in support of the view that the Cladocera are to be derived from a young form of *Estheria* is furnished by the condition of the compound eyes. In the Cladocera also the two compound eyes are united into an eye-bulb and overgrown by a reduplicature of the skin. As has already been shown in connexion with the discussion of the peculiarities of the *Estheria*-type, the forcing asunder and fusion of the two lateral eyes in *Estheria* is connected with the strong lateral compression of the head, and this again with the roofing-over of the head by the shell, and as being due to the same cause is also to be explained the overgrowth of the double eye by a reduplicature of the skin. Now when, in the case of the Cladocera, in the development of the compound eye we find conditions which can only be understood on the theory of an original roofing-over of the head by the shell, these conditions appear as a character which has become established by inheritance, and belonged to an ancestral form whose shell enclosed the head at the sides, and was consequently developed in a similar manner to that which we find in the Estheridæ.

From all the reasons which have been adduced I can only decide in favour of the view that **young forms of Estheridæ**, in which the head was still unobscured by the shell, **were the ancestors from which the Cladocera were developed**; the peculiarities of the Cladocera which were previously mentioned are best understood on this assumption. A possible objection must, however, be considered; for if the overgrowth and fusion of the compound eyes already makes its appearance in *Estheria*-larvæ, in which the head still projects freely from the shell, this fact can only be regarded as a disturbance of the sequence of events in the ontogeny, but not as a proof of the view that the fusion and overgrowth of the eyes have arisen independently of the encasement of the head by the shell. But just as little can it serve as an argument against the theory which I have represented above, that the fusion and overgrowth of the eyes have arisen in the phylogeny only in consequence of the covering of the head by the shell, and therefore after and not before this.

Finally, I will quote the view expressed by Balfour* as to the origin of the Cladocera, according to which "the Cladocera have arisen from some Phyllopod form resembling *Estheria* by a process of regressive metamorphosis."

Since the Cladocera possess such an extensive structural agreement with the Estheridæ, that is, in the first instance, with the young stages of the latter, they are to be regarded as a very young branch of the Crustacea which have only lately split off from Estheridæ, such as we see them represented at the present time, and have become adapted to the pelagic mode of life. Lastly, I derive a similar conception on the part of Claus † from the genealogical tree of the Entomostraca which this investigator has set up, in which no special branch is shown for the Cladocera, which are supposed to be included in the Phyllopod group.

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* F. M. Balfour, 'A Treatise on Comparative Embryology,' German edition, i. Bd., 1880, p. 438.

† C. Claus, "Neue Beiträge zur Morphologie der Crustaceen," Arbeiten des Zool. Institutes zu Wien, Bd. vi., 1885, p. 105.

The Ostracoda.

If the derivation of the Cladocera from *Estheria* succeeds without any difficulty, the same cannot be said of the derivation of the Ostracoda. Yet even in this case it is possible to obtain a sufficient number of connecting-links, such as may support the derivation of the Ostracoda from an Archiphyllopod form belonging to the *Estheria*-type.

In considering this question our attention must again in the first instance be directed to those forms of Ostracoda which appear to be the most primitive. These are to be found in *Cypridina.*

The first feature of the Ostracod body which strikes us is the complete enclosure of the laterally-compressed trunk by a large bivalve shell, which is closed by a muscle. On making an examination of the Euphyllopods, we find the same development of shell and the lateral compression of the body among the Estheridæ. The number of the body-segments is very small in the Ostracoda, and from reasons which have already been discussed this must be regarded as an instance of reduction from the number which were present in a more richly segmented ancestral form. The development of the posterior end of the body as a ventrally flexed furca, provided with hooks directed backwards, shows the entire agreement with the Estheridæ.

Among the appendages the first antenna appears to have a sensory character; yet in shape it is always similar to the appendages which subserve locomotion, and is similarly employed—a condition which, with reference to the original significance of the first antenna as a sense-organ, must be regarded as of a secondary character. The second antenna exhibits in *Cypridina* and likewise in *Halocypris* in a modified degree the form of the biramous swimming-foot-antenna as it persists among the Euphyllopoda in the adult condition in the Estheridæ alone, and appears as the most important organ devoted to the movement of swimming.

A great difference from the Estheridæ as well as from all the other Euphyllopods is seen in the shape of the mandibles and in the appendages of the Ostracoda which correspond to the two maxillæ of the Euphyllopods. The mandible is always provided with a foot-shaped palp, while this is wanting in all Euphyllopods at the period of the complete development of the body. As regards the appendages which are the homologues of the two maxillæ of the Euphyllopods, in the Ostracoda only the first of these is developed as a maxilla; but, as opposed to the reduced maxilla of the Euphyllopods, it is seen to be still traceable to the original shape of the Phyllopod limb. The appendage which is the homologue of the second maxilla of the Euphyllopods is in the Ostracoda "still indeed armed with a maxillary process, yet chiefly constituted for locomotion as a foot" *, and therefore exhibits a general structural agreement with the following appendages. The oral appendages of the Ostracoda consequently undoubtedly display a more primitive shape than those of the existing Euphyllopods, in which degeneration of the mandibular palp and reduction of both maxillæ is a characteristic feature.

Of the characters to be employed for the purpose of comparison I will here further adduce only the compound eye of the Cypridinidæ, which has persisted exclusively in this Ostracod family. The compound eyes of *Cypridina* retain their original position at the sides of the head and have short stalks. Thus there takes place no fusion nor any overgrowth of the two eyes by a reduplicature of the skin, as is the case in the Estheridæ.

A renewed survey of the peculiarities of the Cypridinidæ reveals, on the one hand, characters which allow the Ostracoda to be brought into relation with the *Estheria*-type, thus—the bivalve character and the extent of the shell, which encloses the entire body, the ventrally flexed form of the furca, and the swimming-foot-antenna. On the other hand, however, the Ostracoda exhibit much more primitive characters in the short-stalked compound eyes of the Cypridinidæ, as well as in the development of the mandibles and of the appendages which are the homologues of the Euphyllopod maxillæ.

In answering the question as to how the peculiarities of the Ostracoda admit of being reconciled with the origin of the latter from Estheridæ, it is seen to be impossible to suppose that the Ostracoda are to be derived, like the Cladocera, from Estheridæ with the characters which they at present possess. On the contrary, it may be assumed with good reason that the Ostracoda sprang from old forms of Estheridæ which still possessed stalked eyes like *Branchipus,* and in which neither the reduction of the mandibular palp nor that of the two pairs of maxillæ had appeared, but in which the latter had the original foot-like shape. The peculiarities of the existing Estheridæ in these respects were only developed by them after the Ostracoda had branched off.

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* *Cf.* C. Claus, 'Die Halocypriden des atlantischen Oceans und Mittelmeeres,' Wien, 1891, p. 28.

The idea that the lateral shoot formed by the Ostracoda branched off deep down from the Phyllopod stem also finds expression in the genealogical tree of the Entomostraca which Claus has set up [*]. The close affinity between the Ostracoda and the shell-bearing Phyllopods in particular has likewise been frequently alluded to, as, for instance, by Dohrn [†] and Claus [‡], as well as by Korschelt and Heider [§].

The question as to whether the ancestral forms of the Ostracoda possessed a body composed of numerous segments is to be answered in the affirmative from the standpoint which has already been advanced, that an extensive segmentation of the body is to be assumed also for the old forms of Phyllopods, as being a phylogenetically older condition. In the Ostracoda we have to deal with a group of Crustacea which has proceeded from richly segmented ancient Phyllopods, of the habitus of the Estheridæ, by the process of loss of segments of the body.

THE COPEPODA.

There is no other section of Crustacea in which the entire development of the body has undergone such manifold modifications in accordance with the different mode of life as in the case of the present group. To enter into all these modifications not only lies outside the task which we have imposed upon ourselves, but also would in no way contribute towards answering the question which has been propounded. Here, as before, only those Copepoda which prove to be phylogenetically the oldest forms need be considered, and these are the Branchiura (*Argulus*), and among the Eucopepoda the Calanidæ (among which *Cetochilus* possesses the most primitive characters).

In respect of morphology the Branchiura are an extremely interesting group. The forms at present existing, which are represented only by two genera and few species, are parasitic as regards their nutrition, but have nevertheless retained the faculty of free locomotion. To the last-mentioned circumstance is probably also to be ascribed the retention of old characters.

That the Branchiura are to be assigned to the Copepoda,

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[*] Claus, 'Neue Beiträge zur Morphologie der Crustaceen,' p. 105.

[†] Dohrn, 'Geschichte des Krebstammes,' pp. 133 and 149.

[‡] Claus, 'Untersuchung zur Erforschung der genealogischen Grundlage des Crustaceensystems,' p. 97.

[§] E. Korschelt and K. Heider, 'Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere.' Specieller Theil. ii. Heft, Jena, 1891, p. 500.

and among these represent a special group which contrasts with all others, was first demonstrated in a convincing fashion by Claus *. Above all the transformation of the oral appendage which is the homologue of the second maxilla into a double pair of maxillipeds, as is characteristic of the Copepoda, and then also the shape of the feet in the larval stage, may here suffice as important arguments.

But we also observe in the Branchiura manifold Phyllopod characters, which have always forced themselves upon the notice of investigators. Nevertheless, as for me, my first concern in this question is to inquire whether the Branchiura admit of comparison with existing Euphyllopods, and, if so, with which of them. That it is the **Apodidæ**, and these alone, that offer themselves for a closer comparison will appear from what follows.

The first resemblance between Argulidæ and Apodidæ which strikes us is seen in the shield-shaped development of the cephalothoracic carapace, which, in the case of *Argulus*, covers the three anterior segments of the thorax. This shield is continued as in *Apus* into the anterior margin of the head. Especially when we select for comparison the formation of the cephalothoracic shield in the larvæ of *Apus* the extensive agreement forces itself still further upon us. Claus was also struck by this resemblance, and with reference to it we find in his previously-quoted paper upon *Argulus*, in connexion with the comparison of the Argulidæ with the Siphonostomata, the following passage †:—"Should we wish to bring forward Phyllopods, in order to derive the Argulid form from them, we should be confined to the shield-shaped larvæ of *Apus*, whose mouth-parts are devoid of the maxilliped structures which are so characteristic of the Copepoda, and in conjunction with the foot-rudiments already bear the character of the Phyllopods. Nevertheless this comparison would in itself be morphologically apt, since in the shield-shaped dermal expansions of the parasitic Copepoda and of the young Phyllopoda we recognize equivalent structures." It is precisely upon the great resemblance in formation between the cephalothoracic shield and that of *Apus* that I would here primarily insist.

But there is yet a further peculiarity to be mentioned which *Argulus* has in common with *Apus*, and that is the possession of the compound lateral eyes, which, as in the case of *Apus*, appear to be sunken and covered by the skin. After finding

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* C. Claus, "Ueber die Entwicklung, Organisation, und systematische Stellung der Arguliden," Zeitschr. f. wiss. Zool. Bd. 25, 1875.

† Claus, *loc. cit.* pp. 4, 5.

that the Phyllopod eye is overgrown by a reduplicature of the skin, I interpreted the capsule of the eye of *Argulus*, which was observed by Jurine * and Claus, as being of similar origin †. Subsequent investigations of mine, conducted it is true upon insufficient material, have, however, suggested to me the possibility that in the case of *Argulus* we may have to deal with a modification of the condition which is found in Estheridæ, Cladocera, and *Apus*. According to the figures which lie before me it would be possible that the eye simply separates from the integument and descends into the subjacent tissue. Nevertheless this does not exclude us from bringing both modes of formation into relation one with another and regarding them as modifications of essentially one and the same process. I consider the sinking-in and roofing-over of the compound lateral eyes of *Argulus* as an heirloom from the Apodidæ.

It is also possible to institute a comparison between the shape of the thoracic feet of *Argulus* and the special development exhibited by the foot of *Apus*. In *Argulus* the four pairs of thoracic feet are natatory appendages, and they each consist of a two-jointed axial portion and two narrow rami with many joint-like divisions, so that the entire limb reminds us of that of the Cirripedes. When brought into comparison with the swimming-feet of the existing Euphyllopods the foot of *Argulus*—and the larval conditions must not be left out of consideration—with its elongated stem and the likewise elongated slender rami, proves to resemble most the limb of *Apus* in shape. Herein I have in my mind the common general character of the two forms of limbs rather than an agreement which goes into details. With reference to the other points of agreement, that last alluded to appears to me to be no mere casual one, but to be based upon the close affinity between the two forms. Whether the flagellum which occurs on both the anterior pairs of feet in *Argulus* does not correspond to an epipodial appendage, and consequently is likewise to be regarded as an heirloom from ancestors resembling the Euphyllopods, I would not here attempt to decide; Claus compares it with the lancet-shaped branchial appendage of the Cirripede limb.

No connecting-points for phylogenetic investigations can be gained from the formation of the mouth-parts of *Argulus*, since in consequence of the parasitic mode of nutrition these appendages have been greatly modified. On the other hand,

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* L. Jurine, "Mémoire sur l'*Argule foliacé*," Ann. de Mus. d'hist. nat. t. vii., 1806.

† Grobben, 'Die Entwicklungsgeschichte der *Moina rectirostris*,' p. 56.

the nervous system and digestive organs once more show resemblances to the conditions among the Euphyllopods.

In the organization of *Argulus* we consequently find peculiarities which remind us of *Apus* among the Phyllopods, while we also meet with Copepod characters, and, lastly, points of resemblance to the Cirripedes. For our present consideration the *Apus*-characters are of the first importance; we shall have to revert to the others again later on.

On submitting the characters of the Eucopepoda to examination with reference to the question under discussion, we meet with great difficulties at the first glance.

The segmentation of the body in the Eucopepoda is more extensive than in *Argulus*. While all segments are fully developed, as is seen also in the Calanidæ, the most primitive of Eucopepods, we find that in addition to the head five thoracic and five abdominal segments are present. In this respect, in comparison with the Branchiura, the Eucopepods exhibit a more primitive condition.

On the other hand, the cephalothoracic shield, which in *Argulus* is of fairly large proportions, is only extremely feebly developed in the Eucopepoda, and has undergone degeneration, no doubt in connexion with the rapid locomotion of these pelagic animals, for which a large carapace would be in no case of advantage. If we compare it with the shell-structures of the Euphyllopods we soon come to the conclusion that the cephalothoracic shield of the Eucopepods can only be referred to the shield of *Apus*. As in the case of *Apus* and also in *Argulus*, the edge of the rudimentary lateral reduplicature forming the cephalothoracic shield of the Eucopepods is continued into the anterior margin of the head. In general this condition appears more distinctly in the Nauplius-larvæ of the Eucopepoda, which also in other respects exhibit Euphyllopod characters, since moreover the shield of the Nauplius sometimes still possesses a broad flat shape. The flat development and the mode of connexion of the cephalothoracic shield with the anterior margin of the head already referred to belong to the *Apus*-character.

In the formation of the cephalic appendages the Eucopepoda exhibit more primitive conditions than the Branchiura. Here again it is the Calanidæ which will have to be considered. The first antenna in the Calanidæ, as in all free-living Copepods, is very long and serves for locomotion. Its colossal size in comparison with its original development as a sensory antenna and its utilization as an organ of locomotion are, like the analogous development of the first antenna among the Ostracoda, to be considered as of a secondary nature.

The second antenna has preserved the form of the biramous swimming-foot, while this is likewise retained in the palp of the mandible. The maxillæ and the double pair of maxillipeds, produced by the separation of the outer and inner rami of the second maxilla, exhibit the shape of the Phyllopod limb. As opposed to *Apus* the most primitive Eucopepods, the Calanidæ, with reference to what must be assumed to have been the ancestral forms of all existing Crustacea, possess more primitive characters in the retention of the biramous second antenna and of the mandibular foot, as well as of the foliaceous foot-shape of maxillæ and maxillipeds. In *Apus*, indeed, the second antenna is wanting in the adult state or is only present in a vestigial condition, and similarly the mandibular palpi are absent and both maxillæ reduced in size.

The thoracic feet of the Eucopepods exhibit the swimming-foot shape which is characteristic of the group—a two-jointed stem and a pair of three-jointed elongated rami. For their special shape a connexion is to be found in the case of *Apus* among the Euphyllopods. The special swimming-foot-like development of the limbs of *Apus* may here be emphasized once more. The Copepod foot, however, has lost the epipodial appendages by degeneration; the segmentation of its two rami was probably originally more extensive, as we may conclude from the shape of the foot in *Argulus*. The elongated form of the Eucopepod furca, too, occurs again among the Apodidæ, and in this connexion the larval conditions of the latter must in the first place be considered.

The compound lateral eyes have usually disappeared in adult Eucopepods, and are retained in a modified form only in the Pontellidæ*. On the other hand, I was able to prove† that in the Nauplius-stages of *Cetochilus* (and this in all probability also applies at least to the other free-living Eucopepods) extensive rudiments are present for the paired lateral eye, but these nevertheless undergo degeneration after they have severed their original connexion with the integument. Consequently, after the facts which have been adduced there can be no doubt that the ancestors of the Eucopepods possessed compound lateral eyes, and that these merely underwent degeneration at a later date. A comparison between the sinking-in of the eye of *Apus* and the severance of the eye-rudiments from the integument in *Cetochilus* as a

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* *Cf.* C. Claus, "Das Medianauge der Crustaceen," Arbeit der zoolog. Instituts zu Wien, Bd. 9, 1891, p. 26.

† C. Grobben, "Die Entwicklungsgeschichte von *Cetochilus septentrionalis*," ibid. Bd. 3, 1881, pp. 20 and 36.

modification of the process must not be rejected, especially with reference to the position of the compound eyes in the larvæ of Cirripedes.

From what has been stated as to the Copepods the following conclusions may be drawn with regard to their affinity to the Euphyllopods:—Among the Copepods the Branchiura are in the first place to be considered as the group which in general have preserved what are phylogenetically more ancient characters, although in many respects, as in the formation of the cephalic appendages, secondary modifications have set in owing to the parasitic mode of nutrition. The Branchiura consequently represent a remnant of a primitive Archicopepod group. The isolated position occupied by the Branchiura among the Copepoda, as well as the small number of genera (*Argulus* and *Gyropeltis*) and species by which these animals are represented at the present day, are in accordance with this conception. In this sense, too, in the genealogical tree of the Entomostraca, to which reference has already several times been made, Claus has made the root of the Branchiuran twig arise from the bottom of the Copepod branch.

This Archicopepod group had, judging from the structure of *Argulus*, **the habitus of** *Apus*; consequently, according to my theory it is to be derived from that Archiphyllopod series which led to the existing Apodidæ, the character of which it already bore. Its branching-off from the *Apus*-series, however, took place at a period when the forms belonging to this series possessed the biramous swimming-foot-antenna, the mandibular foot, and foliaceous-foot-shaped maxillæ, and accordingly lies deep down on the stem of the Apodiform Archiphyllopods. To judge from the peculiarities of the lateral eye in *Argulus*, the sinking-in and covering-over of the compound lateral eyes were processes which already occurred in these ancestors of *Apus* from which the Copepods sprang. There is also no need to point out specially that the Copepods too, like the Ostracods, have proceeded from a much more extensively segmented form through reduction of the segments of the body.

THE CIRRIPEDIA.

A consideration of the adult Cirripedes furnishes but very few points of importance for the answering of the question as to their origin. This is moreover to be accounted for by the altogether exceptional mode of the attachment of these animals by the cephalic end, and the changes in the development of many organs which ensue from these conditions. In the case of the Cirripedes it is chiefly the developmental stages that furnish the evidence necessary for the question of origin.

Among the Cirripedes the Lepadidæ (forms like *Pollicipes**) are to be regarded as the most primitive. The first thing which strikes us in the organization of this family, besides the peduncle-shaped development of the cephalic end, is the complete enclosure of the body by a mantle-shaped shell. The mouth-parts are short, the mandibles devoid of palps, the two pairs of maxillæ small. Of the two antennæ the second has disappeared, while the first serves as an organ of attachment. The six pairs of thoracic legs are provided with long many-jointed rami thickly clothed with setæ, and the abdomen appears to be completely reduced.

Above all, the mantle-shaped shell reminds us of the bivalve shell of the Estheridæ, and would afford justification for a derivation from Archiphyllopods resembling *Estheria.* Yet a closer consideration of the developmental stages shows that such a derivation is incapable of accomplishment, since these stages structurally conform to the conditions found in the Copepods and in the Apodidæ among the Euphyllopods.

The extensive structural agreement between the developmental stages of the Cirripedes and those of the Copepods was demonstrated by Pagenstecher † and Claus ‡. The Cirripede Nauplius closely resembles the Copepod Nauplius, and in the so-called *Cypris* stage the shape of the thoracic feet as swimming-appendages, as well as the segmentation of the abdomen and the formation of the furca, repeat the conditions which exist in the case of the Copepods.

Since the idea that the Cirripedes are closely allied to the Copepods appears to be thoroughly in accordance with facts, it must also be possible to derive the Cirripedes, like the Copepods, from Archiphyllopods which possessed the habitus of *Apus.* As a matter of fact, such points of agreement with

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* *Cf.* A. Weithofer, "Bemerkungen über eine fossile *Scalpellum*-Art aus dem Schlier von Ottnang und Kremsmünster, sowie über Cirripedien im Allgemeinen," Jahrbuch der k. k. geolog. Reichsanstalt, 1887, 37 Bd., p. 376.

† A. Pagenstecher, "Untersuchungen über niedere Seethiere aus Cette.—IX. Beitrag zur Anatomie und Entwicklungsgeschichte von *Lepas pectinata*," Zeitschr. f. wiss. Zool. Bd. 13, 1863.

‡ C. Claus, "Die Cypris-ähnliche Larve (Puppe) der Cirripedien und ihre Verwandlung in das festsitzende Thier," Schriften der Gesellsch. zur Beförderung der gesammten Naturwiss. zu Marburg, Supplementheft v., 1869. Also 'Untersuchungen zur Erforschung der genealog. Grundlage des Crustaceensystems,' pp. 79–88.

Apus can be shown to exist, and they are to be looked for in the first instance in the Nauplius conditions. The Nauplius of the Cirripedes agrees with that of the Phyllopods, and among these with that of *Apus*, even more than with the Copepod Nauplius. As *Apus*-like characters I may point out the shield-shaped expansion of the shell, which is directly continuous with the anterior margin of the head, and moreover the presence of the compound lateral eyes, which, as in the case of *Apus*, lie beneath the integument. The lateral eyes have separated from the skin and are deep-seated, and consequently in this respect they agree with the rudiments of the lateral eyes of the Eucopepod Nauplius (and probably also of *Argulus*). As in the latter case, so in that of the Cirripedes, I regard the separation of the eyes from the skin and their downward change of position as a modification of the process observed in *Apus*, where the eye is overgrown by the integument. In the so-called *Cypris* stage of the Cirripedes also the compound eye retains this position.

If the comparison just instituted is correct we must expect to find still more points of agreement with the Cirripedes in the case of the Argulidæ than in that of the Eucopepoda. This also is exactly what takes place. The paired lateral eyes of *Argulus*, which have likewise passed beneath the skin, are copies of the paired eyes of the Cirripede Nauplius. The thoracic feet of *Argulus* show a similarity to the Cirripede limbs, as has already been asserted by Claus, and also the flagellum of the two first thoracic feet of *Argulus* might, according to Claus *, be comparable to the lancet-shaped appendage of the Cirripedes, in which case, however, it might still correspond to an epipodite. *Argulus* consequently does not merely prove to be a form intermediate between the Apodidæ and Eucopepods, but also possesses the same significance between Cirripedes and Copepods. In *Argulus* therefore we find a mixture of characters belonging to Copepods, Cirripedes, and *Apus*.

Since, as I think, an objection can hardly be raised to the close affinity of the Cirripedes to the Copepods, we now arrive at a solution of the question as to how we are to interpret the bivalve shell of the Cirripedes. We must agree with Pagenstecher and Claus † in regarding the bivalve Cirripede shell as a special adaptation from the shield-shaped rudimentary shell as it appears in the Copepod Nauplius. It has conse-

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* C. Claus, 'Ueber die Entwicklung, Organisation, &c. der Arguliden,' p. 34.

† C. Claus, 'Untersuchungen zur Erforschung der genealogischen Grundlage des Crustaceensystems,' p. 83.

quently proceeded from the flat shell. This being so, still less do we meet with any difficulty in deriving the formation of the shell of the Cirripedes from the shell of *Apus*.

The Cirripede shell is, however, only apparently bivalve, and its similarity to the Ostracod shell in the so-called *Cypris* stage is merely external. From the condition of the shell in this stage its agreement with the shell of *Apus* can still be demonstrated in spite of the external dissimilarity. A closer consideration of the shell in the *Cypris*-like larva shows that the shell is anteriorly **directly continuous with the anterior margin of the head.**

Thus it also comes to pass that the right and left portions of the shell are united on the ventral side in the anterior half of the animal, and the cleft which leads into the mantle-cavity only commences far back. The shell of the Cirripedes is consequently an undivided one, as in *Apus*, merely extending backwards in direct continuation of the anterior margin of the head. It would therefore be advisable not to call the Cirripede shell bivalve, but to exclusively apply to it the often-used term " mantle-shaped " (" mantelförmig ").

With reference to the common origin of Copepods and Cirripedes, which results from the foregoing, it only remains to discuss the mouth-parts of the latter, on account of their different formation from those of the Copepods. The shape of the mouth-parts of the Eucopepods, such as *Cetochilus*, which have to be cited in this comparison, exhibits primitive conditions, as has already been shown. In the Cirripedes, on the other hand, the mandibles are devoid of palps, while the two pairs of maxillæ which follow them appear reduced and developed in such a way that the similarity of the mouth-organs to those of the Euphyllopods is certainly great. From this circumstance a decided difficulty would result as regards a common derivation for the Copepods and Cirripedes, and it would be an argument in favour of a separate origin of the Cirripedes from the Archiphyllopods if this similarity of the mouth-parts were to be explained as being due to direct inheritance; in addition to this there would be the fact that, while for the Archiphyllopod ancestral form of the Copepods the possession of palp-bearing mandibles and maxillæ in the shape of foliaceous feet is to be presupposed, the Cirripedes would have to be derived from forms in which the formation of the mouth-parts which is characteristic for all existing Euphyllopods must already have appeared. Taking into consideration the great agreement between the Cirripedes and Copepods in, as it seems to me, more important characters, the similarity in development between the mouth-organs of the Cirripedes and those of the Euphyllopods is to be interpreted as an adaptation which has been evolved independently in this lateral branch from foot-like mouth-organs.

The Cirripedes therefore in all probability are of common origin with the Copepods and sprang from Archiphyllopods, as is also represented by Claus in his genealogical tree of the Entomostraca, and, moreover, they arose deep down from forms which as yet showed no reduction of the mouth-parts. **This Archiphyllopod ancestral form of the Copepods and Cirripedes belonged**—and to this I would here attach especial weight—**according to its habitus to the Apus-series.** The agreement to be detected in many respects between the Argulidæ and Cirripedes indicates that the root of the former is to be sought in the neighbourhood of the fork of the common branch for Copepods and Cirripedes.

The view that the Cirripedes and Copepods belong to a common stem has not been undisputed. Thus it has been represented by Balfour * that the Cirripedes are to be derived directly from an old form of Phyllopod with two shells. The development of the shell and also the possession of the paired lateral eyes, as well as the larval history of the Cirripedes, were the decisive points in Balfour's opinion. This author regards the so-called *Cypris*-stage in the development of Cirripedes as a phyletic one which "more or less accurately represents an ancestral form of the Cirripedes," and he considers that "both the bivalve shell as well as the compound eyes are ancestral characters." To the similarity in shape at this stage between the thoracic appendages and Copepod feet Balfour attaches no great weight.

Balfour is entirely correct in designating the compound lateral eyes as ancestral characters; but these constitute no difficulty in the way of a common origin of Copepods and Cirripedes, since the Argulidæ possess the paired eye, and rudiments of the lateral eyes are also formed in the Eucopepod Nauplius, but afterwards merely undergo degeneration. On the other hand, it has already been shown that a close comparison of the mantle-shaped Cirripede shell with the bivalve shell-formations is untenable, and that it appears possible to derive the shell of the Cirripedes from a shield-shaped one. From this it appears that the peculiar formation of the shell is a cœnogenetic character of the larvæ. And yet it is simply and solely this superficial agreement of the shell of the so-called *Cypris*-stage with that of the Ostracods

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* F. M. Balfour, 'Comparative Embryology,' German translation, i. Bd., 1880, p. 482.

that occasions the similarity of this larval stage to the bivalve Crustacean forms, while the shape of the thoracic feet, of the abdomen, and of its furcal appendages completely exhibits the Copepod character, and there is nothing in the way of the interpretation of these features as being of phyletic value. The absence of the second antenna is explicable as being due to the mode of life of the Cirripedes, and to be understood from the modification of the entire animal in consequence of its having become fixed. In this connexion I would further remark that the loss of the second antenna in the Cirripede group has developed independently and is in no way to be brought into genetic relation with the loss of the same appendage in the existing Apodidæ.

The theories of Balfour are shared also by Fowler *, who, however, in opposition to Balfour imagines a common origin for the Cirripedes and Ostracods from Archiphyllopod forms, and consequently goes even further than Balfour, who supposes that the Ostracods originated independently from the main Crustacean stem.

In agreement with Balfour, Korschelt and Heider † also assume that the Cirripedes arose from an Archiphyllopod form provided with a bivalve shell and, indeed, resembling the ancestral form of the Ostracods. In forming their decision as to the ancestral form of the Cirripedes, Korschelt and Heider likewise base their conclusions upon the *Cypris*-like larva. They assign no decisive value to the resemblance in the formation of the thoracic appendages, nor to the agreement between this larval stage and the Copepods with reference to the number of the segments of the body, since these points could have been acquired independently. On the other hand, the presence of the large bivalve shell is considered to be of primary importance, while after this the absence of the typical Copepod characters (degeneration of the lateral eyes and of the dorsal shield, and cleavage of the second maxilla into a double pair of maxillipeds) in the so-called *Cypris*-larva of the Cirripedes is also alluded to.

With reference to the first-mentioned point I may appeal to what has already been stated, and I would merely add that I too, in forming a decision as to the common origin of the Copepods and Cirripedes, attach no special weight to the agreement in the number of the segments of the body in each

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* G. H. Fowler, "A Remarkable Crustacean Parasite, and its Bearing on the Phylogeny of the Entomostraca," Quart. Journ. Micr. Sci. vol. xxx. 1890, pp. 115-119.

† Korschelt and Heider, "Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere.—Specieller Theil," ii. Heft, pp. 500-501.

case, although I regard the fact as worthy of notice, and I am inclined to consider this agreement as only of secondary importance.

With regard, however, to the absence of the abovementioned typical Copepod characters in the case of the *Cypris*-like larva of the Cirripedes, it appears to me that we ought not to expect to find these characters at all in the larva in question. A common origin for Copepods and Cirripedes is not to be taken to mean that the Cirripedes sprang from typical Copepods (*i. e.* of the Eucopepod type), but that they arose from an ancestral form which was common to both groups, and in which those most typical Copepod characters were not yet developed. The ancestral form was consequently an animal in which, to refer to what are rightly indicated in this connexion by Korschelt and Heider as Copepod characters, the paired lateral eyes, as well as a broad dorsal shield, were still present, and the conversion of the second maxillæ into the double pair of maxillipeds had not yet set in, while the thoracic feet perhaps agreed in shape with those of *Argulus*.

On the same grounds is to be found the solution of the supposed difficulty raised by Hoek [*], that the *Cypris*-like larva, which is so characteristic of the ontogeny of the Cirripedes, is altogether absent in the development of the Copepods. The *Cypris*-larva of the Cirripedes is a typical Cirripede stage, and was acquired by these Crustacea at a period when they had already separated from the ancestral form which was common to the Copepods as well as to themselves.

THE MALACOSTRACA.

The Malacostraca constitute a well-defined natural group. In the Leptostraca (*Nebalia*) there are preserved for us remnants of an old Crustacean type, which may with justice be regarded as being very closely allied to the ancestral form of the existing Malacostraca. On the other hand the Leptostraca exhibit peculiarities which remind us of the Euphyllopods.

As primitive characters of *Nebalia*, when contrasted with the other Malacostraca, we must regard the number of the abdominal segments, which is one in excess of that found in the remainder of the group, the preservation of the furca, the foliaceous shape of the thoracic appendages, which represent a mixture of the Schizopod and Phyllopod foot, and lastly in all probability also the shape of the shell.

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[*] P. P. C. Hoek, "Report on the Cirripedia collected by H.M.S. 'Challenger' during the years 1873–76: Zoology, Part xxv.," 1883, p. 17.

The latter three peculiarities are to be regarded as Phyllopod characters, and with them in like manner must also be classed the stalked eye.

The attempt to bring *Nebalia* into closer comparison with one of the three Euphyllopod types proves to be more difficult than in the case of the other groups of Crustacea. In this instance the quickest way of arriving at a result will be by the process of exclusion.

A closer comparison between Estheridæ and *Nebalia*, which might appear to be justified on the basis of a certain similarity in the shell, is soon found to be impossible. In this connexion I merely recall the development of the postabdomen and furca which is characteristic of the Estheridæ, where this portion of the body appears ventrally flexed and terminates with claws. If the Apodidæ be adduced, the shield-shaped formation of the shell as well as the peculiar habit of the thoracic limbs again admit of no connexion. Consequently *Branchipus* alone remains, to which most resemblances may be pointed out. On the one hand we have the development of the branches of the caudal fork, which in *Nebalia* so greatly resemble those of *Branchipus*, owing to their form and the fact that they bear setæ along their entire margin, that the term "branchipodiform" has been applied to them by Claus*. As a further point of agreement we next come to the stalked condition of the eyes, as well as the shape of the thoracic limbs of *Nebalia*, which bears most analogy to the foliaceous form found in *Branchipus*, although in this respect the resemblance is much smaller. These, however, are the only characters which can be turned to account for the purpose of establishing a closer affinity between *Nebalia* and *Branchipus*.

In my opinion the difficulty of this comparison lies in the manifold modification which is exhibited by the *Branchipus* type when contrasted with its probable ancestors. The very absence of a shell gives *Branchipus* a greatly altered appearance as opposed to the other types; this condition is probably to be explained as being due to the loss of a shell which was originally present. This may perhaps have resembled the shell of *Nebalia* in shape; whether it also possessed the cephalic valve (Kopfklappe) can scarcely be determined. The sharp division, too, between thorax and abdomen in *Branchipus* proves to be a secondary condition. Since the number of the thoracic and abdominal segments does not agree with that of those of *Nebalia*, in which there is similarly a

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* C. Claus, "Ueber den Organismus der Nebaliden und die systematische Stellung der Leptostraken": Arbeiten aus dem zoolog. Institut zu Wien, Bd. viii. 1888, p. 128.

sharp demarcation between thorax and abdomen, this separation of the two regions of the body cannot be utilized as a proof of a closer affinity between the two forms referred to. In the possession of appendages upon six of the abdominal segments *Nebalia* exhibits more primitive conditions than *Branchipus*, in which the abdomen is devoid of limbs. The special development of the second antenna, as well as of the oral appendages of *Branchipus*, and the agreement of the latter organs with those of the rest of the Euphyllopods would, since this is undoubtedly likewise a case of secondary transformations of appendages which were originally differently constituted, not have much weight in this comparison with *Nebalia*, where in these respects much more primitive conditions are to be met with.

While considering all the circumstances which have been indicated, we shall still find ourselves continually reverting to *Branchipus* in our search for a connexion with *Nebalia* among the existing Euphyllopods. The supposition that in the *Branchipus* type we may actually recognize an Archiphyllopod remnant, from which the Malacostraca have arisen, will, as containing much probability, find a further support in a subsequent consideration.

Into the relationships of the different groups of Malacostraca I need not enter further. A genealogical tree, which best exhibits the affinity of the Malacostraca, has been set up by Claus *, and the reader may be recommended to consult it. I would merely suggest that the origin of the lateral branch for the Stomatopoda as represented in it should be moved somewhat higher up, and indeed that it should not be sought for until the Archischizopods are reached, from which, in my opinion, the Stomatopoda have developed as a separate offshoot. Above all, the youngest Stomatopod larva (*Erichthoidina*), which was described by Claus †, exhibits such manifold relations to the Schizopods that the view which I have expressed appears to be thereby confirmed.

While on this subject I would nevertheless refer to a peculiarity of the Stomatopods, as opposed to all other Malacostraca with the exception of *Nebalia*, which has not hitherto been sufficiently appreciated. This is the *rostral plate*, which appears in various shapes, and is jointed to the anterior margin of the cephalo-thoracic shield. The structure in question reminds us of the cephalic valve of *Nebalia*, with which it is

* C. Claus, 'Neue Beiträge zur Morphologie der Crustaceen,' p. 104.

† C. Claus, "Die Metamorphose der Squilliden": Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen, xvi. Bd. 1871, Taf. i. fig 1.

probably also homologous. So far as can be concluded from the observations at present available [*], it must be supposed to arise by being segmented off from the anterior margin of the cephalo-thoracic shield, just as also in the case of *Nebalia* the cephalic valve arises in this manner. The development of the rostral plate of the Stomatopods is connected with the segmenting off of the anterior part of the head, which bears the eyes and the first antennæ. I would at any rate regard it as an heirloom from *Nebalia*, which has been preserved with a peculiarity in the formation of the head, or else has developed again by a process of atavism. In the event of this interpretation being correct, we may draw from it the further conclusion that the rostral plate (cephalic valve), or at least a corresponding process, developed for the protection of the stalked eyes, probably also formed part of the primitive *Branchipus*-shell, and that this was no longer developed among the Schizopods, as well as the forms arising from them, but that the portion equivalent to it is to be looked for in the rostrum of the shell, which thereby acquires a heightened interest from a morphological point of view. The possession of a movable rostral plate is to be assumed for the Archischizopods. Finally, it must be further remarked that Claus [†] has expressed himself in opposition to a homologization of the cephalic valve of *Nebalia* with the rostrum of the Malacostracan shell [‡].

SUMMARY AND CONCLUSION.

In the preceding pages the attempt has been made to refer the Crustacea which are united in the group Entomostraca, as well as the Malacostraca, to the three types which are to be distinguished among the Euphyllopods existing at the present day, namely, *Branchipus*, *Apus*, and *Estheria*. On making a comparison between the most essential characters in the different outward structure of these forms it has been found that the Cladocera and Ostracoda can be referred to ancestral forms resembling *Estheria*, while the Copepoda and Cirripedia

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[*] *Cf.* Claus, *loc. cit.* pp. 133 & 142.

[†] Claus, "Ueber den Organismus der Nebaliden, &c.," p. 39.

[‡] I feel bound to remark that, on the other hand, I, in accordance with Claus (*loc. cit.*), do not regard as justifiable the homologization of the cephalic valve of *Nebalia* with the rostrum of the Copepods, to which G. O. Sars ("Report on the Phyllocarida collected by H.M.S. 'Challenger' during the years 1873-1876:" The Voyage of H.M.S. 'Challenger,' Zoology, vol. xix. 1887, p. 31) alludes. The so-called rostrum of the Copepods has nothing to do with that of the Malacostraca, and has arisen entirely independently in the Copepod group.

admit of being traced back to an ancestral form like *Apus*, and the Malacostraca probably to one of which a remnant is represented by the *Branchipus*-type.

That the three Euphyllopod types, which are so different in outward appearance, can be regarded as remnants of ancestral forms which presented a general agreement with them, is also conversely again rendered probable by the existence of Crustacean groups bearing characters of these types in the Animal Kingdom of to-day. **The existence of the three Euphyllopod types, *Branchipus*, *Apus*, and *Estheria*, and that of Crustacea which are referable to these types, are facts which mutually support one another.**

In order to prove this proposition, I must go somewhat further afield.

I believe I am correct in stating that Hatschek* was the first to declare that only when a larval or embryonic form of higher animals exhibits a great agreement with the adult stage of lower animals is it possible to conclude with much probability that this corresponds to a similar ancestral form. Thus, we should not be in a position to conclude with a similar show of probability that the Trochosphere larva of the Annelids and Mollusks is a repetition of an ancient ancestral form which resembled it, if there were not still in existence at the present day Rotifers exhibiting great agreement with the Trochosphere stage.

From the existence of developmental stages, which we recognize as of phyletic value, may be drawn the further conclusion that similar conditions in the form of sexually mature animals must not only have existed during a long period of time, but also must manifestly have enjoyed a wide distribution. The idea that a form of this kind was once widely distributed is again supported by the fact that animal types agreeing with such developmental stages in structure have persisted until the present time.

From the application of these propositions a further support may be gained for the views which have been developed by me with reference to the origin of the Crustacea.

If in the existing Animal Kingdom we find three Euphyllopod types which are strikingly different in appearance, and all other Crustaceans at present living show certain points of agreement with these three types, then, as it seems to me, additional probability has in consequence been gained, not only for the theory that these three Euphyllopod types represent remnants of Crustacea which were formerly very

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* B. Hatschek, 'Lehrbuch der Zoologie,' Erste Lieferung, 1888, pp. 25, 26.

widely distributed, but also for the view that the rest of the Crustacea at present in existence are referable to the three types in question. In the special application of this conclusion to the *Branchipus*-type, I derive from the fact of the preservation of this type and of the high development of that of the Malacostraca a further proof of the theory that the special points of agreement, albeit only small, between the two types may be turned to account in the sense of establishing a closer affinity, and that consequently the Malacostraca are referable to the *Branchipus*-type.

So far as is possible I have endeavoured to establish the view cherished by myself, that **the Ostracoda and Cladocera admit of being traced back to the *Estheria*-type of the Euphyllopoda, the Copepoda and Cirripedia to that of *Apus*, and the Malacostraca to that of *Branchipus*, and that the existing Crustacea are to be derived from three ancestral forms corresponding to these types.** The following genealogy (p. 468), which, moreover, essentially agrees with that set up by Claus, repeats this conception in tabular form.

From this genealogical tree it is evident that the *Branchipus*-series in ancient times gave origin to a great Crustacean group, that of the Malacostraca; that to the *Apus*-series is likewise to be traced a great group, comprising the Copepoda and Cirripedia; and that, lastly, the *Estheria*-series in ancient times also gave rise to a similar stem, that of the Ostracoda, while at a more recent date it once more gave off a lateral branch in the shape of the Cladocera *. A further point in agreement with the theory that the Cladoceran stem did not arise until a later period is the existence of an intermediate series leading to the Cladocera and consisting of different genera of Estheridæ (*Limnadia*, *Limnetis*), while all other groups of Crustacea appear to be sharply separated from the Euphyllopods at present living.

According to these conceptions it is possible to establish a natural system of classification among the Crustacea of which the Entomostracan group is composed, from which there also

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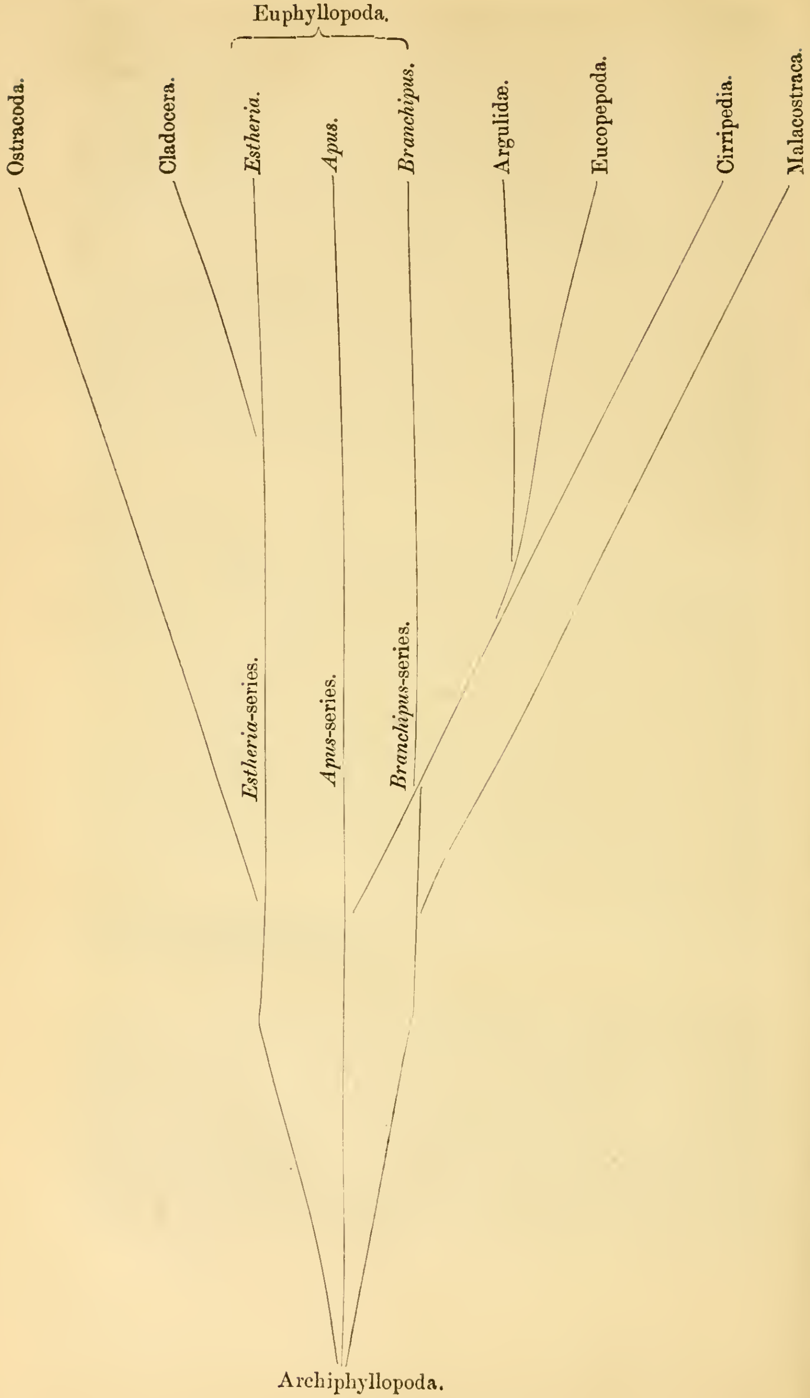
* This is probably the best place to quote the following statement by Dohrn ('Geschichte des Krebstammes,' p. 132), since we may gather from it that Dohrn asked himself the question how the existing Euphyllopod types are related to the other Crustacean groups in respect of phylogeny. The passage in question runs as follows:—"But however it may be with regard to Gigantostraca and Trilobites, in any case the order Phyllopoda remains the matrix for all other forms of Crustacea at present in existence. It is true that there is no way leading us into one of the other orders either through *Apus* or through *Branchipus*, but from *Nebalia* as well as from the shell-bearers we have to follow the course of the development of powerful series of forms."


Euphyllopoda.
Ostracoda.
Cladocera.
Estheria.
Apus.
Branchipus.
Argulidæ.
Eucopepoda.
Cirripedia.
Malacostraca.
Estheria-series.
Apus-series.
Branchipus-series.
Archiphyllopoda.

results an alteration in the classification of the Crustacea in general. **The group Entomostraca should be dissolved, and a number of groups formed from it, which are to be considered as equivalent to the Malacostraca.** One of these natural divisions is formed by the Euphyllopods in conjunction with the Cladocera; the Ostracoda are to be regarded as a second special group of equal value, which has arisen from the *Estheria*-type. The Copepoda and Cirripedia admit of being combined in a third group, which may be designated *Apodiformes.* In accordance with this the Ostracoda may be termed *Estheriæformes*—a group, however, into which the Cladocera cannot be received, on account of their separate origin from the *Estheria*-series; the Cladocera must remain united with the Euphyllopods, since they are derived from Estheridæ of the recent type. A fourth large natural group, which can be traced back to the *Branchipus*-series, is constituted by the Malacostraca. In conformity with the designations previously chosen, this group also might be named *Branchipodiformes.*

The classificatory system of the Crustacea would consequently assume the following shape :—

Class **CRUSTACEA.**

Subclass I. PHYLLOPODA.

Order 1. *Euphyllopoda.*
2. *Cladocera.*

Subclass II. ESTHERIÆFORMES.

Order *Ostracoda.*

Subclass III. APODIFORMES.

Order 1. *Copepoda.*
2. *Cirripedia.*

Subclass IV. MALACOSTRACA (BRANCHIPODIFORMES).

I. LEPTOSTRACA.

Order *Nebaliadæ.*

II. EUMALACOSTRACA.

Order 1. *Stomatopoda.*
2. *Thoracostraca.*
3. *Arthrostraca.*

In a similar manner Balfour[*] has already divided the Crustacea into a number of groups and has distinguished the following sections as of equal value:—I. Branchiopoda; II. Malacostraca; III. Copepoda; IV. Cirripedia; V. Ostracoda. Although the guiding points of view of the descent appear similarly decisive in Balfour's case also for the foundation of these groups, they differ from mine in so far as a tracing-back of these groups to the three Phyllopod types is not considered.

With reference to the subdivision of the Malacostraca, I would remark that the Arthrostraca and Thoracostraca represent the groups distinguished by Claus, with the difference that I set them down as orders. The separation of the Stomatopoda as a special group equivalent to the Arthrostraca and Thoracostraca appears to me to be well-founded, owing to the great difference which these Crustaceans exhibit when contrasted with the other Thoracostraca with which they were united. It corresponds to the theory of their separate origin from Archischizopods, as I have already explained. Claus[†] interprets the great difference between the Stomatopoda and the rest of the Thoracostraca and Arthrostraca in somewhat different fashion, since he even regards the Stomatopoda as having arisen separately from Archimalacostraca. The agreement of the Stomatopoda with the Thoracostraca and Arthrostraca in the formation of the telson and in the number of the abdominal segments, as well as the great agreement of the youngest known *Erichthoidina*-larva with the Schizopods, decides me to combine the Stomatopods as Eumalacostraca with the two groups mentioned, and to derive them all from Archischizopods, and, on the other hand, to place the Leptostraca, which, with Claus, we must regard as remnants of Archimalacostraca, in contrast to the Eumalacostraca. By the retention of the branchipodiform furca, the larger number of the abdominal segments, and the peculiar shape of the thoracic feet as well as of the shell, the Leptostraca are proved to be much more primitive than all other Malacostraca. In order to give clear expression to my view as to the affinities of the Stomatopoda, the genealogical tree of the Malacostraca may here be given; its agreement in other respects with that set up by Claus will appear from a comparison of the two.

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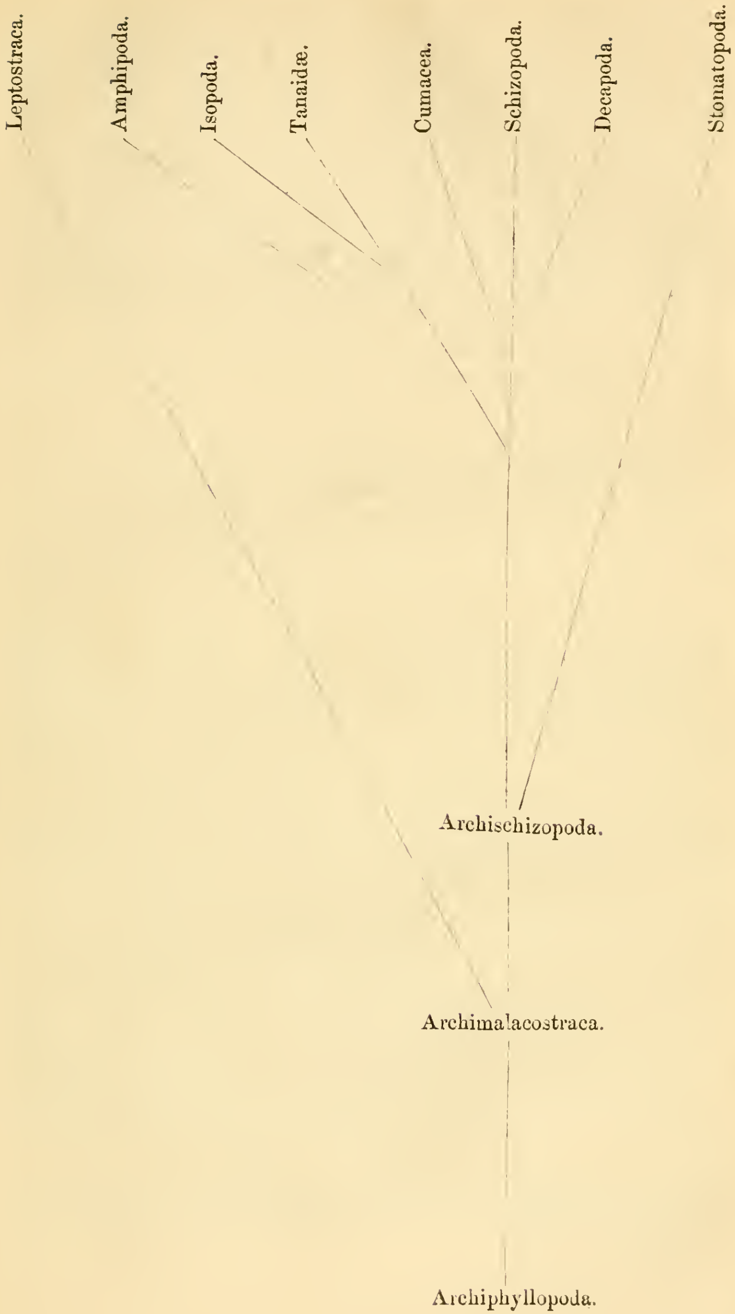
[*] Balfour, *op. cit.* p. 434, note 1.

[†] Claus, 'Neue Beiträge zur Morphologie der Crustaceen,' pp. 96 and 104.


Leptostraca.
Amphipoda.
Isopoda.
Tanaidæ.
Cumacea.
Schizopoda.
Decapoda.
Stomatopoda.
Archischizopoda.
Archimalacostraca.
Archiphyllopoda.

With reference to the Euphyllopods, there is, however, a difficulty still to be disposed of. If the views which I have here set down are correct, and in the existing Crustacea are to be seen the descendants of three Archiphyllopods which differed in outward form and may be met with again in the three types, *Branchipus*, *Apus*, and *Estheria*, what is the explanation of the fact that in these three representatives of old ancestral forms, which have at any rate existed side by side for a long time separated in three series of forms of different *habitus*, the degeneration of the mandibular palp and the reduction of both maxillæ is to be found in the same manner? That the peculiar development of the mouth-parts in existing Euphyllopods is a secondary character will not be questioned any more than the assumption that the old ancestral forms possessed mandibular palp and maxillæ like foliaceous feet, as is evident from the existence of such mouth-parts in the case of the Ostracoda, Copepoda, and Malacostraca.

In my opinion the degeneration of the mandibular palp, as well as the diminution in size of the maxillæ in the *Branchipus*-, *Apus*-, and *Estheria*-series of Euphyllopods, took place independently, and are to be explained as an instance of convergence. This convergence finds a further explanation in the origin of the three series alluded to from a common primitive form, in which there existed a similar tendency to development in the directions indicated. Moreover we find that the degeneration of the mandibular palp is of frequent occurrence, as in the Cyclopidæ among Copepods and also in the Cirripedia, which latter also possess maxillæ of a diminished size.

In so far as a proof can be given I have endeavoured to give it, in order to establish the view that the three Euphyllopod types at present existing, which are so very divergent from one another in external structure, are remnants of three ancient Archiphyllopod series to which the rest of the Crustacea now living can be traced back. The changes in the system of classification are merely the result of these views.

That much that was already known has been repeated in the course of the argument cannot be made a subject of reproach against this consideration of the question, since it is chiefly a case of fresh combination of known facts. Neither can blame be attached to the omission to notice many systems of organs, since many of these furnish no points for my argument. It is self-evident that only those organs could be brought forward in which sufficient differences in formation appear with reference to their resemblance to the three Euphyllopod types.

A retrospect of the speculations which have been set up and the views which have been expressed will allow much to appear as requiring to be confirmed by further observation. Nevertheless we should not under-estimate the difficulty of proof in the treatment of a question in which sometimes even but slight indications of old peculiarities must be of importance. This difficulty, however, will not be permitted to suppress the attempt at an elucidation. The circumstance that arguments may really be pointed out everywhere will allow this consideration of the case to appear admissible, while the fact that every attempt at an elucidation ought to be made will show that it is justifiable.

LXXIII.—*Report upon the Stomatopod Crustaceans obtained by P. W. Basset-Smith, Esq., Surgeon R.N., during the Cruise, in the Australian and China Seas, of H.M.S. 'Penguin,' Commander W. U. Moore.* By R. I. Pocock, of the British (Nat. Hist.) Museum.

[Plate XX. B.]

During the past two years the Trustees of the British Museum have received from the Lords of the Admiralty an immense and very valuable series of Crustacea obtained by Mr. P. W. Basset-Smith, of H.M.S. 'Penguin,' in the Australian and China Seas.

The Stomatopoda alone of this series form the subject of the present communication; but it is probable that when the rest of the material is examined, the remainder of the orders will be found to be equally well represented by new and interesting forms.

I may add that, during a recent visit to the British Museum, Dr. H. J. Hansen, of Copenhagen, made a thorough revision of our extensive collection of Squillidæ. Amongst other important innovations, Dr. Hansen has suggested more than one new generic name for certain species that have been hitherto referred to previously existing genera; but until he has himself published the descriptions of these genera, I have not considered it advisable to adopt them.

(1) *Squilla fasciata*, De Haan.

Two specimens. Chusan (10–14 fath.); Holothuria Bank (34–36 fath.).

(2) *Squilla affinis*, Berthold.

Chusan (10–14 fath.); Kowlson Bay (Hong Kong), Holothuria Bank (China Sea) (38–52 fath.).

The specimens from Kowlson Bay and Holothuria Bank closely resemble the specimen named *gracilis* by Miers in the distribution of the patches of black pigment upon the segments of the abdomen and on the telson, as also in having the telson somewhat narrower than appears to be normally the case in *Sq. affinis*, and its spines longer. They resemble the typical form, however, in having only four or five spines on the raptorial limbs, and not six or seven, as in the example of *gracilis*. The specimens in question thus appear to be intermediate in characters between *gracilis* and *affinis*, from which we may conclude that the former can scarcely be permitted to rank as a distinct variety.

(3) *Pseudosquilla oculata* (Brullé).

A single example from Macclesfield Bank (China Sea).

(4) *Pseudosquilla ciliata* (Fabr.).

Three young examples from the Arafura Sea.

(5) *Gonodactylus chiragra* (Fabr.).

Baudin Island, Troughton Island, Damma Island, Baleine Bank (15–20 fath.), Amboina Bay, Arafura Sea, Macclesfield Bank (32 fath.).

A large number of specimens.

I doubtfully refer to this species a semi-larval form, measuring 9 millim. long, from Baleine Bank, which differs from the adult in having only a single median crest upon the telson.

(6) *Gonodactylus graphurus*, Miers.

N.W. Australia (20 fath.); Baudin Island (8–15 fath.); Baleine Bank, N.W. Australia (15–20 fath.); Arafura Sea; Holothuria Bank, China Sea (15–24 fath.).

A great number of examples.

The Squillidæ in the British Museum included by Mr. Miers under this head contained examples of genuine *graphurus* and others which have subsequently been made into a distinct species, *G. glaber* (erroneously spelt *glabrous*), by Brooks. Still later Dr. de Man has united the two again; but since the dorsal grooves characteristic of *graphurus* are well marked, without signs of failing, in all the adult specimens obtained by Mr. Bassett-Smith, it has not seemed to me advisable at present to adopt Dr. de Man's opinion.

In one semi-larval form (10 millim. in length) from Baleine Bank the groove is represented only upon the fifth abdominal tergite.

(7) *Gonodactylus Smithii*, sp. n. (Pl. XX. B. fig. 1.)
(? Var. of *G. chiragra*.)

Colour a deep green, obscurely mottled, the manus of the raptorial limb reddish purple, the distal extremity of the penultimate segment indigo-blue; a reddish-purple spot on the inner side of the distal extremity of the large segment of the appendage.

This species is closely allied to *G. chiragra*, from which it appears to differ in being more robust and in the ornamentation of the telson and of the sixth abdominal tergite. The crests upon these two plates are the same in number as in *chiragra*, but are much more compressed and carinate. Thus on the sixth abdominal tergite the crests are ridges, flat above and produced without constriction into long spines, which considerably overlap the hinder border of the tergite; in *chiragra* these crests are wider, convex above and rounded behind, the spines being very short and sharply defined from the rest of the crest. In the telson, again, the median prominence is a strongly compressed ridge, the upper edge of which is almost straight and the posterior angle is regularly produced into a long strong spine; all the other crests are similarly compressed and carinate; in *chiragra* the median crest is convex above, sometimes tipped with a small spine, rounded behind and scarcely compressed.

The following measurements (in millimetres) will show the stouter build of this new form:—Total length (from base of rostrum to notch of telson) 23·5; width of fifth and first abdominal somites and of carapace 4·5, of second free thoracic somite 4·3; length of carapace 6·3, of eye 2·8.

An example of *chiragra* measuring 23 millim. in length has the fifth abdominal somite and the carapace only 3·8 millim. wide, the latter plate being 5·6 millim. long and the eye-stalk 2·5. Again, an example of *chiragra* with the abdomen 4·5 millim. wide measures 27 millim. long, the carapace being 7 millim. long and the eye-stalk 2·8. A second example of *Smithii* measuring only 17 millim. long shows corresponding differences when compared with an example of *chiragra* of the same length. These comparisons show that, in addition to being stouter in body, the eyes are longer in *Smithii*.

Two examples (♂ ♀) from the Arafura Sea, both possibly young.

A number of young examples of *chiragra*, both surpassing and falling short of these in size, were taken at the same time and in the same locality, and there is no difficulty whatever in distinguishing those that are here named *Smithii*. Dr. Hansen, however, when naming the Museum collection of Stomatopoda referred an exactly similar form to *G. chiragra*, so that it is possible that the view here expressed may be erroneous.

(8) *Gonodactylus excavatus*, Miers.

A single male example dredged at a depth of 26 fath. on Macclesfield Bank.

The rediscovery of this species is interesting, the locality of the type being unknown. The figure of the telson of this species given on pl. iii. of Mr. Miers's paper is very inaccurate. The excavation is represented as much wider than it really is, and the posterior angles of the telson appear to be single, whereas in reality they are double, consisting of two subequal processes.

(9) *Gonodactylus trispinosus*, Dana.

Two small examples from Baleine Bank (N.W. Australia).

Under this species, in his revision of the Squillidæ, Mr. Miers mentions two males that were obtained at Sharks Bay (W. Australia). According to Dr. Hansen, these examples belong to a different species, namely *G. stoliura* of F. Müller.

(10) *Gonodactylus tuberosus*, sp. n. (Pl. XX. B. fig. 2.)
(? Var. of *trispinosus*.)

Very closely allied to the preceding, *G. trispinosus*, the only differences between the two that I have noticed being found in the form of the rostrum and of the telson. In *trispinosus* the lateral spines of the rostrum are longer, thinner, and are directed forwards and outwards, so that if prolonged in the same direction they would pass along the outer border of the eyes. In *tuberosus*, on the other hand, the spines are much shorter and stouter, being directed forwards, so that the prolongation of their axes would pass through the external half of the eyes. Again the telson of *tuberosus* is more squared and its posterior angles less rounded; the prominences, too, are considerably larger, the median being almost spherical and so high that its summit is on a level with the summits of the median tubercles of the sixth abdominal tergite, although these tubercles are themselves considerably more elevated than in *trispinosus*; moreover, the lateral tubercles of the telson are also much less elongate and more spherical; the notches separating the lobes of the telson are wider than in *trispinosus*, the external notch being particularly well-marked and widening towards the margin of the plate.

Measurements in millimetres of largest specimen :—Length from apex of eyes to end of telson 40; length of eye 3·3, width of cornea 2; length of telson 7·5, width 8·2.

Two examples from Macclesfield Bank, at a depth of 37 fath.

(11) *Gonodactylus Hansenii*, sp. n. (Pl. XX. B. fig. 3.)

Belonging to the same group as *G. Edwardsii, scyllarus, cultrifer*, &c.

Colour (in alcohol) a uniform yellowish pink, with a black patch of colour on the second segment of the external ramus of the swimmeret.

Eyes very large and globular, at least as large as in *G. Edwardsii*. The dorsal plate of the ophthalmic somite deeply bifid in front. *Antennal scales* about the same relative size as in *G. scyllarus*, being considerably shorter than the carapace.

Rostrum with evenly convex anterior border and evenly rounded angles.

Manus of the raptorial limbs moderately dilated at the base and armed with nine distinct, sharp, subequal teeth. The margins of the three posterior thoracic tergites narrowed and not dilated even as in *G. scyllarus*.

The margins of the abdominal somites thickened as in *G. scyllarus*, the posterior angles spined as in that species. The sixth abdominal tergite and telson closely resembling these plates in *G. scyllarus*, the median being elevated, carinate, and posteriorly spined as in that species; the crests on each side of the median one not so close to it as in *scyllarus*, and not divided by a groove; the median crest not continuous with the crest upon the internal spiniferous process, while the external crest, which in *scyllarus* lies close to the external edge of the anterior half of the telson, is situated more internally, being in the same line as the external edge of the median process on each side.

The movable spines on the exopodite of the swimmeret are longer than in *scyllarus*, the apex of the distal one being on a level with the margin of the distal segment of this appendage; moreover the crests upon the endopodite of the swimmerets are unequal in size, the exterior being considerably longer and stronger than the interior; in *scyllarus* they are subequal.

Measurements in millimetres:—Length (from anterior margin of rostrum to the median notch of telson) 60; length of carapace at the side 14, of antennal scale 11; width of rostrum 4, length 2; length of eye and width of cornea 4; width of telson 10, length from anterior end of median keel to median notch 8.

A single female example from Macclesfield Bank, 35 fath.

On the whole this species seems to come nearest to *G. scyllarus.* It differs, however, in the arrangement of the crests of the telson, the size of the eyes, the form of the rostrum, the bifid ophthalmic tergite, and the number of teeth on the raptorial limbs. In having large eyes and many teeth on the raptorial limbs it resembles *G. Edwardsii*, Berth., but differs in the structure of the telson, the small antennal scales, form of rostrum, &c.

(12) *Gonodactylus carinifer*, sp. n. (Pl. XX. B. fig. 4.)

Belonging to the same section as the preceding, *G. Hansenii*, but closely related to *G. cultrifer.*

Colour (in alcohol) a uniform ochraceous tint, the dorsal surface marked everywhere with fine, close-set, irregular star-shaped patches of pigment.

Eyes very large and globular. The dorsal plate of the ophthalmic somite with its antero-lateral margins directed upwards.

Rostrum ovately convex, its extremity bent downwards. Antennal scale rather large, a little shorter than the carapace measured along the dorsal middle line. The manus of the raptorial limb moderately dilated and armed with *three* distinct sharp subequal teeth. The margins of the free cephalothoracic tergites not dilated; the posterior angles of the posterior abdominal tergites spinous. The sixth abdominal tergite furnished with six posteriorly spined crests.

The telson almost exactly like that of *G. cultrifer* (White), except that the median crest is much lower, being only about half as high as it is long, with its upper edge only lightly convex, and that there is no trace of a crest near the external margin of the anterior half of the telson.

Measurements in millimetres:—Length from anterior edge of rostrum to median notch of telson 27, of carapace at the side 7, of antennal scale 5·6; length of eye 3, width of cornea 2·8; width of telson 5, length from median notch to anterior edge of median keel 3·8.

A single male example from Holothuria Bank (China Sea), 24 fath.

Judging by its size the example here described is young, and it is necessary to bear in mind that it may prove to be the young of *G. cultrifer*. Since, however, it appears to have all the characters of an adult, I have decided, at all events provisionally, to regard it as a distinct form. It may be at once recognized from *G. cultrifer* by the presence of *three*, and not two, teeth on the hand of the raptorial limb, and by the lowness of the median crest of the telson.

EXPLANATION OF PLATE XX. B.

Fig. 1. *Gonodactylus Smithii*, sp. n.; last abdominal tergite and telson from above, × 2. 1 *a*. Ditto, ditto, from the side, × 2.

Fig. 2. *Gonodactylus tuberosus*, sp. n.; last abdominal tergite and telson from above, × $\frac{3}{2}$. 2 *a*. Ditto, ditto, from the side, × $\frac{3}{2}$. 2 *b*. Ditto, rostrum.

Fig. 3. *Gonodactylus Hansenii*, sp. n.; anterior end of body. 3 *a*. Ditto, last abdominal tergite and telson, from above, × 2. 3 *b*. Ditto, ditto, from the side.

Fig. 4. *Gonodactylus carinifer*, sp. n.; anterior end of body. 4 *a*. Ditto, last abdominal tergite and telson, from above. 4 *b*. Ditto, ditto, from the side; nat. size.

BIBLIOGRAPHICAL NOTICE.

Éléments de Paléontologie. Par Félix Bernard &c. Première Partie (pages 1 à 528), avec 266 figures dans le Texte. 8vo. Baillière, Paris, 1893.

Palæontology is here treated in a very full and masterly manner. The object and history of the Science are first noticed. Its relationship to Biology and Geology is clearly defined, and the necessity of a knowledge of these, as collateral studies, is insisted on. Its history extends from the ancient recognition of fossil shells having once been marine, to the systems of modern philosophy, comprehending far-advanced theories of natural history in its many branches, and the now-established doctrine of Evolution. Chapter II. deals with the definition of "Species," gradations of varieties, and transitional forms; also how far natural selection and the influence of locality and requirements have had effect. Correlation of structure and rudimentary organs are considered; and parallelism and convergence among forms, also aberrant and synthetic types, are carefully exemplified. How far there may be a vital force in species and in larger groups, and whether the perfection of races and individuals may be looked for, are among the problems still waiting for elucidation by the study of facts. In Chapters III. and IV. the Author defines natural classification and phylogeny, referring to the help of comparative anatomy in the study of the evolution of organs, and the unity of plan. The importance of Embryogeny in these researches is shown; and a recognition of the geological continuity of beings is indispensable. This leads to the consideration of successive faunas and floras through geological times; and how they may have been influenced by locality and by changes in marine and freshwater conditions; also by variations of climate. Chapters V. and VI., after explaining why and how organic beings have become fossilized, give a classification of the known strata and the general palæontological characters of their greater divisions.

The Author clearly shows how Biology cannot be mastered if the study of Fossils be omitted, since both the living and the extinct forms come under the law of evolution in a not yet fully understood complex, of which some constituent lines have been traced, whilst numerous coils and networks have yet to be unravelled. Leaving much of the technical work of a palæontologist in the field and the laboratory to be learnt from other instructors, M. Bernard proceeds to elaborate the special object of this portion of his work, namely Animal Palæontology, in a most orderly and painstaking manner, and with numerous satisfactory figures in the text, all clear and definite, and almost, if not quite, all newly drawn from good sources. The Author has evidently endeavoured to master the details of each group, but still caution must be taken in following him in every case. We unfortunately opened the book at page 325, where a few mistakes at once appear—thus *Edwardsi* is misprinted "*Edward*;" the figure of the *Palæocypris* is an inferior and reversed copy of the original, with some inaccuracies in the letters of reference to parts; fig. 156, E, is not Barrande's *Bolbozoe*; and the diagnosis of M'Coy's *Beyrichia* is incorrect. Without further fault-finding we wish to recommend this work as evidently the result of good honest work by a palæontologist possessed of many, but not necessarily of all, of the special qualifications wanted in so very wide a field of research.

The Protozoa occupy pages 77–107, and comprise the Foraminifera and Radiolaria. The Spongiaria occupy pages 107–130, the Cœlenterata pages 130–194, the Echinodermata pages 195–322, and the Arthropoda pages 323–397; the Nemathelmintha are mentioned at page 397; the Vermes Ciliati comprise the Bryozoa (pages 398–401), Brachiopoda (pages 401–440), and Chætopoda (pages 440–442); the Mollusca partly—thus Amphineura (page 444), Gasteropoda (pages 445–524), and a few pages (524–528) making a commencement of the Lamellibranchiata. The foregoing and other names of the groups are given in French, not Latin. The relative attention given to each is approximately represented by the number of pages indicated above.

The bibliographic references throughout are numerous and useful, and valuable classificatory and other tables are to be found in their right places. With the Second Part of the work doubtless a good Index and full Table of Contents will be given, and these will be very useful.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

February 8, 1893.—W. H. Hudleston, Esq., M.A., F.R.S., President, in the Chair.

The following communication was read:—

"Note on a Radiolarian Rock from Fanny Bay, Port Darwin, Australia." By G. J. Hinde, Ph.D., V.P.G.S.

A specimen brought from Fanny Bay by Captain Moore, of H.M.S. 'Penguin,' is of a dull white or yellowish tint, in places stained red. It has an earthy aspect, and is somewhat harder than chalk, but gives no action with hydrochloric acid. Microscopic sections show a fairly transparent groundmass, apparently amorphous silica, containing granules and subangular fragments up to ·075 millim. in diameter, some of which appear to be quartz.

Besides this, the rock contains numerous radiolaria, and it is really a radiolarian earth intermediate in character between the Barbados earth and such cherts as those of the Ordovician strata of Southern Scotland.

The details of the extent of the deposit and its relationship to other rocks of the area are not yet obtainable, though it is possible that a considerable thickness of rock mentioned by Mr. Tenison Woods as occurring in this area may also be of radiolarian origin.

The Author describes a species of *Cenellipsis*, two of *Astrophacus*, one of *Lithocyclia* (new), one of *Amphibrachium*, three of *Spongodiscus* (one new), four of *Spongolena* (all new), two of *Dictyomitra* (both new), one of *Lithocampe* (new), and two of *Stichocapsa* (both new).

From these it is not practicable at present to determine the geological horizon of the rock; with one exception, all the genera represented occur from Palæozoic times to the present.

MISCELLANEOUS.

Notes on Chœropsis liberiensis (*Morton*).

By Henry C. Chapman, M.D.

It is well known that the late Dr. Samuel G. Morton, regarding certain peculiarities presented by the skull of the hippopotamus inhabiting the west coast of Africa as specific in character, proposed, in communications made to the Academy [*], that the latter should be distinguished from that of the east coast as *Hippopotamus minor*, afterwards *liberiensis*, the former retaining the name of *Hippopotamus amphibius* given to it by Linnæus [†]. The Academy having afterward acquired an entire skeleton of the Liberian hippopotamus, the late Dr. Leidy took up anew the study of its osteology, and more especially of the skull. After a most careful comparison of the skulls of the two species Dr. Leidy came to the conclusion that

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[*] Proc. Acad. N. S. 1844, vol. ii. p. 14; Journ. A. N. S. vol. i. 1849, p. 231.

[†] Syst. Nat. ed. 12, vol. i. p. 10 (1766).

the hippopotamus of Liberia differed so much from that inhabiting the Nile, the Cape of Good Hope, &c., that the Liberian animal should be considered as constituting not only a distinct species, but a distinct genus, and proposed[*] that the new genus should be named *Chærodes*. Learning, however, that this name had already been appropriated, having been previously given to an insect, Dr. Leidy suggested that the name *Chærodes* should be changed to *Chœropsis*[†]. While Dr. Leidy's views as to the generic distinction between *Hippopotamus* and *Chœropsis* have been accepted by such high authorities as Gratiolet[‡], Milne-Edwards[§], and Huxley[||], by many zoologists *Chœropsis* is regarded as a species of *Hippopotamus*, and by some only as a variety of *Hippopotamus amphibius*[¶]. Thus, for example, Flower[**], a very high authority, does not consider the difference in the shape of the cranium and in the number of the incisor teeth in the lower jaw as warranting the establishment of the genus *Chœropsis*. The difference presented by the crania in the two kinds of hippopotamus Flower regards as similar to those "between the tiger and the smaller species of *Felis*, the gorilla and baboons and the smaller allied apes." In the judgment of the author, however, it may be at least questioned whether the differences existing between the smaller species of *Felis* do not justify separating them into distinct genera. On the other hand, although the gorilla has descended in all probability from some baboon-like form, zoologists do not as yet recognize these two apes as species of the same genus. The fact that *Hippopotamus amphibius*, syn. *Tetraprotodon*, has, according to Gaudry[††], exhibited in one instance unilateral hexaprotodontism, and *Chœropsis*, according to Flower[‡‡], in one instance unilateral tetraprotodontism, would influence but few palæontologists in regarding, like Lydekker[§§], *Hexaprotodon*, *Tetraprotodon*, and *Chœropsis* as merely species of one genus, *Hippopotamus*. *Hexaprotodon* and *Tetraprotodon*, with the incisor formula $\frac{3}{3}-\frac{3}{3}$ and $\frac{2}{2}-\frac{2}{2}$ respectively, are still considered either as subgenera, as they were originally by Falconer and

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[*] Proc. A. N. S. 1852, vol. vi. p. 52.

[†] Journ. A. N. S. ser. 2, vol. ii. 1853, p. 213.

[‡] 'Recherches sur l'anatomie de l'Hippopotame,' Paris, 1867, p. 202. Gratiolet, apparently ignorant of Leidy's description, named the Liberian hippopotamus *Ditomeodon*.

[§] 'Recherches sur les Mammifères,' Paris, 1868–1874, p. 43.

[||] Huxley, 'Anatomy of Vertebrated Animals,' 1872, p. 319. At least, Huxley says, "The Hippopotamidæ are represented at present only by the genera *Hippopotamus* and *Chœropus*." "*Chœropus* has only two incisors in the lower jaw"—by *Chœropus* is, presumably, meant *Chœropsis*.

[¶] Carus, 'Zoologie,' 1868, p. 145.

[**] Proc. Zool. Soc. London, 1887, p. 612.

[††] Bull. Soc. Géologique, ser. 3, vol. iv. p. 504.

[‡‡] *Op. cit.*

[§§] 'Memoirs of the Geological Survey of India,' 1884–1886, vol. iii. p. 47.

Cautley[*], or as genera, as by the greatest of British palæontologists, the late Sir Richard Owen[†]. The latter view being accepted by the author, *Chœropsis*, with the incisor formula $\frac{2}{1}-\frac{2}{1}$, and differing in other respects far more from the living hippopotamus (*Tetraprotodon*) than the latter does from the extinct one (*Hexaprotodon*), should certainly be regarded as a genus distinct from *Hippopotamus*.

It appears to us that too much importance has been attached by Lydekker and Flower to the presence of an extra incisor tooth in the lower jaw of *Hippopotamus amphibius* and *Chœropsis* respectively, especially as it has only been noticed once in either case. We would rather regard the presence of such an incisor tooth as an individual peculiarity and as an instance of redundancy than of reversion. In view of what has already been urged by Leidy, Gratiolet, and Milne-Edwards in favour of distinguishing *Chœropsis* as a genus distinct from *Hippopotamus*, there is but little further to be added. It may be mentioned, however, in this connexion, that the brain of *Chœropsis* as described by Macalister[‡] differs very considerably from that of the adult hippopotamus dissected by Garrod[§] and of the young animal dissected by the author[||], the differences between the two brains being essentially the same as those presented by the casts of the cranial cavities described and figured by Milne-Edwards. The above remarks are made on the occasion of the presentation to the Academy by Mr. W. E. Rothery, Consul of the Liberian Government, through Mr. Arthur E. Brown, of a fine skin and skeleton of the *Chœropsis liberiensis*. The value of this generous gift will be better appreciated when it is known that the only specimen of *Chœropsis liberiensis* ever exhibited abroad was the one that lived only five minutes after its arrival at the Zoological Garden of Dublin, and which constituted the subject of the dissection made of that animal by Macalister. So far as known to the author, with the exception of the skin presented to the Academy this evening there are but two others in collections—those referred to by Milne-Edwards and Flower. Our *Chœropsis* is 5 feet 3 inches in length and 2 feet 5 inches in height, the latter measurement being taken from the shoulder. The colour of the skin appears to have been originally of a bluish black, fainter in some parts than others, and presenting, therefore, a somewhat mottled appearance. The difference in colour from that of the *Chœropsis* described by Milne-Edwards, which is represented as of a reddish hue, may possibly have been due to the liquor in which the skin was preserved. It is more probable, however, that *Chœropsis* varies in colour. In other respects our specimen resembles that described and illustrated by Milne-Edwards.—*Proc. Acad. Nat. Sci. Philad.* 1893, pp. 185–187.

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[*] Falconer, 'Palæontological Memoirs,' vol. i., 1868, p. 140.

[†] 'Odontography,' 1840, p. 566.

[‡] Proc. Roy. Irish Acad. 2nd ser. vol. i., 1873, p. 494.

[§] Trans. Zool. Soc. Lond. 1880.

[||] Proc. Acad. Nat. Sci. 1881, p. 126.

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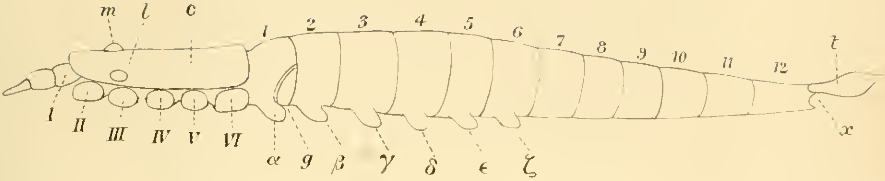

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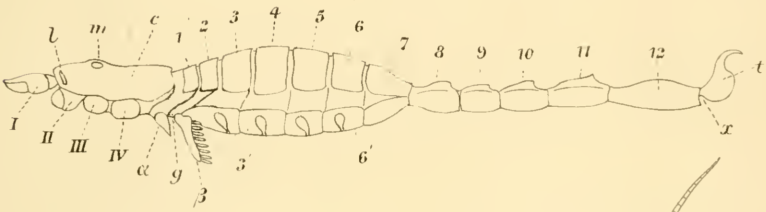

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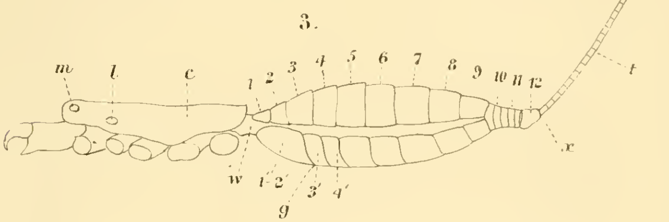

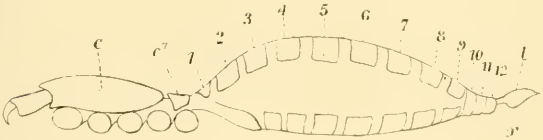

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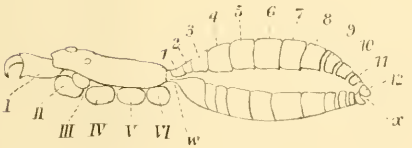

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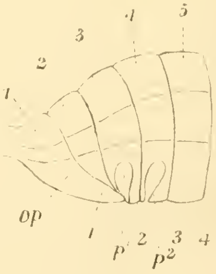

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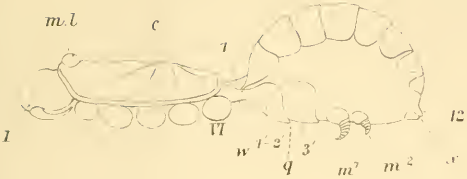

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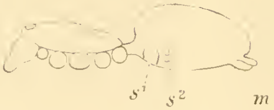

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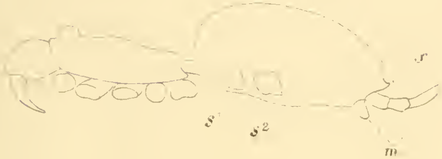

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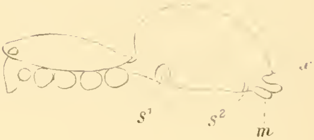

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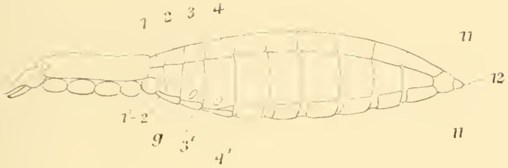

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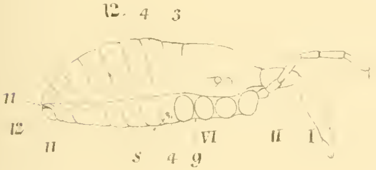

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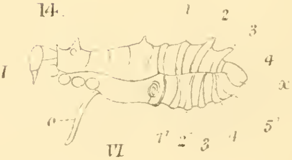

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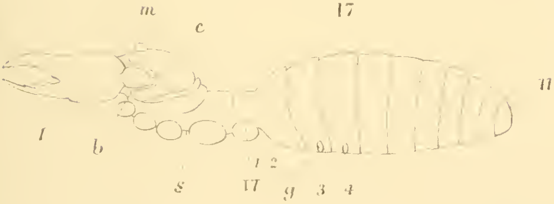

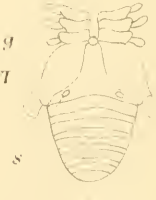

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Mintern Bros. lith.

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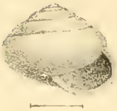
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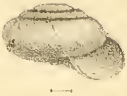
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R. Mintern del. et lith.

Mintern Bros. imp.

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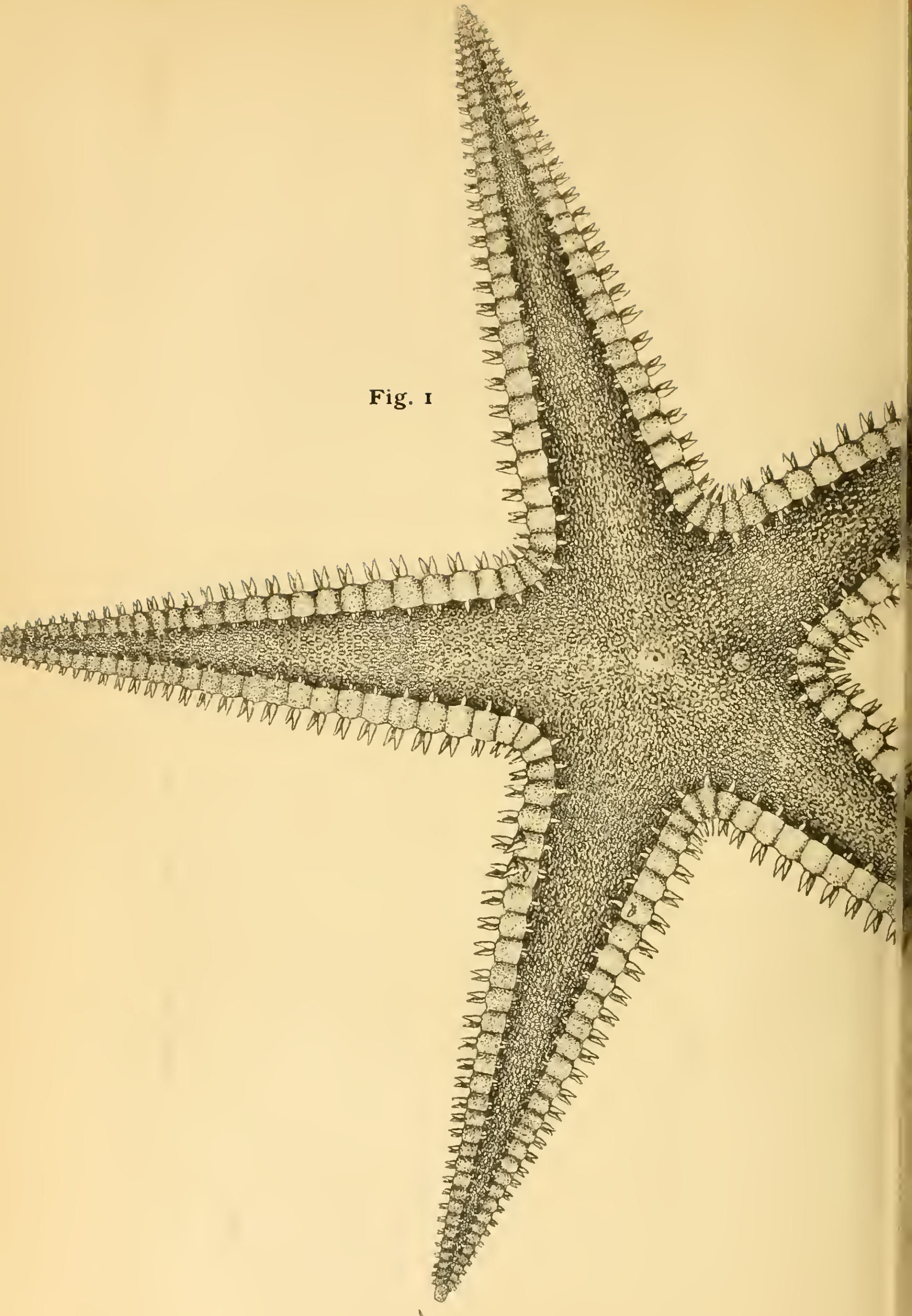

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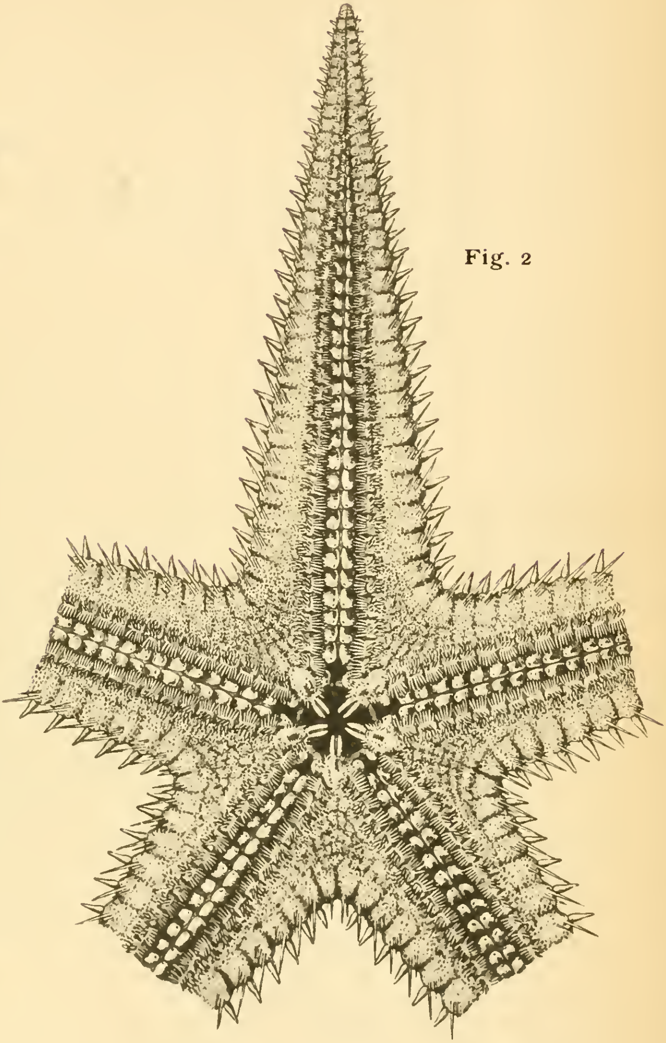


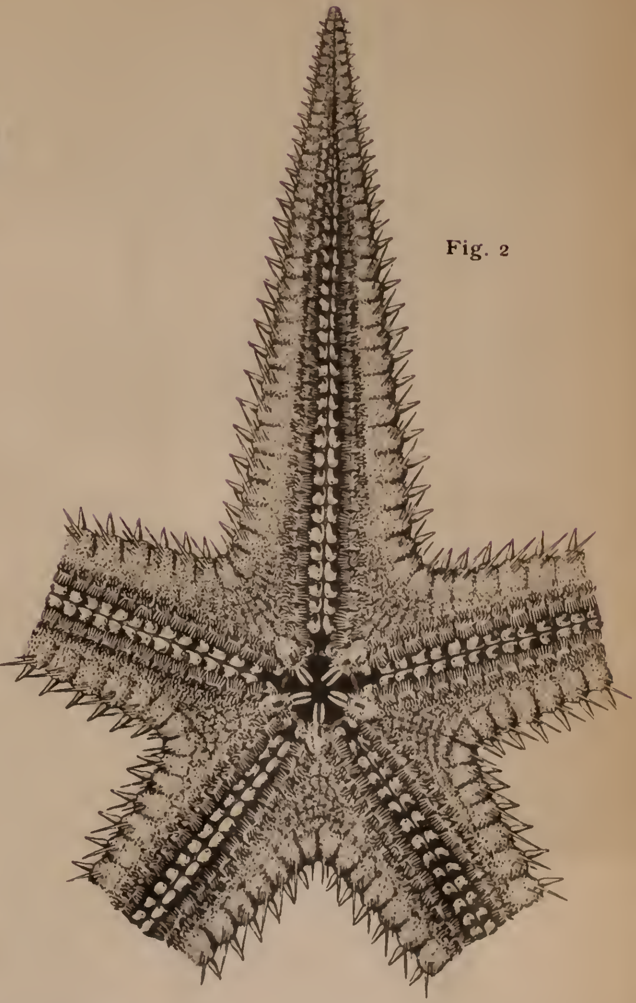
Fig. 2

PERSEPHONASTER CROCEUS. ACTINAL VIEW.

Fig. 1

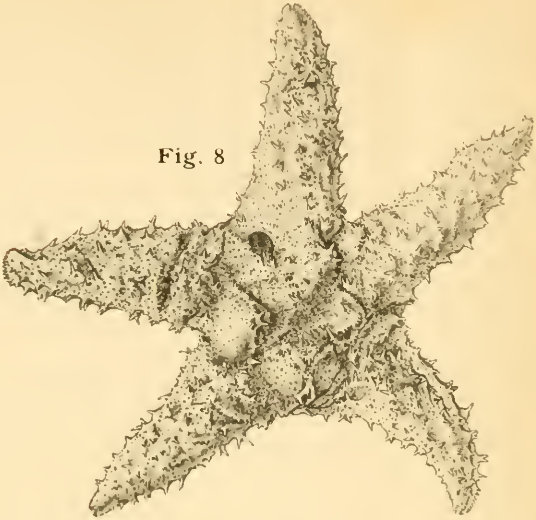
PERSEPHONASTER CROCEUS. ABACTINAL VIEW.

Fig. 2



PERSEPHONASTER CROCEUS. ACTINAL VIEW.

Fig. 8



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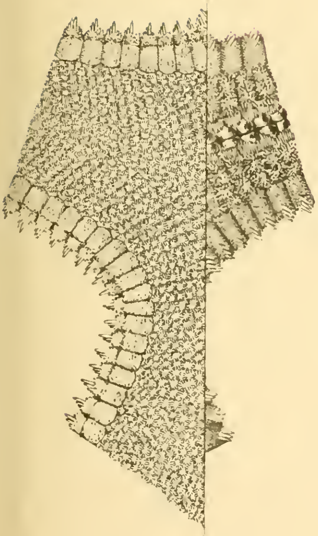
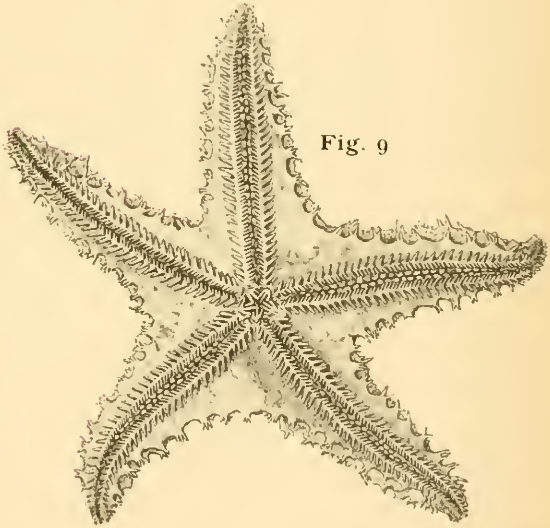
ABACTINAL SURFACE



IPSACASTER RFACE.

Fig. 9



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ACTINAL SURFACE.

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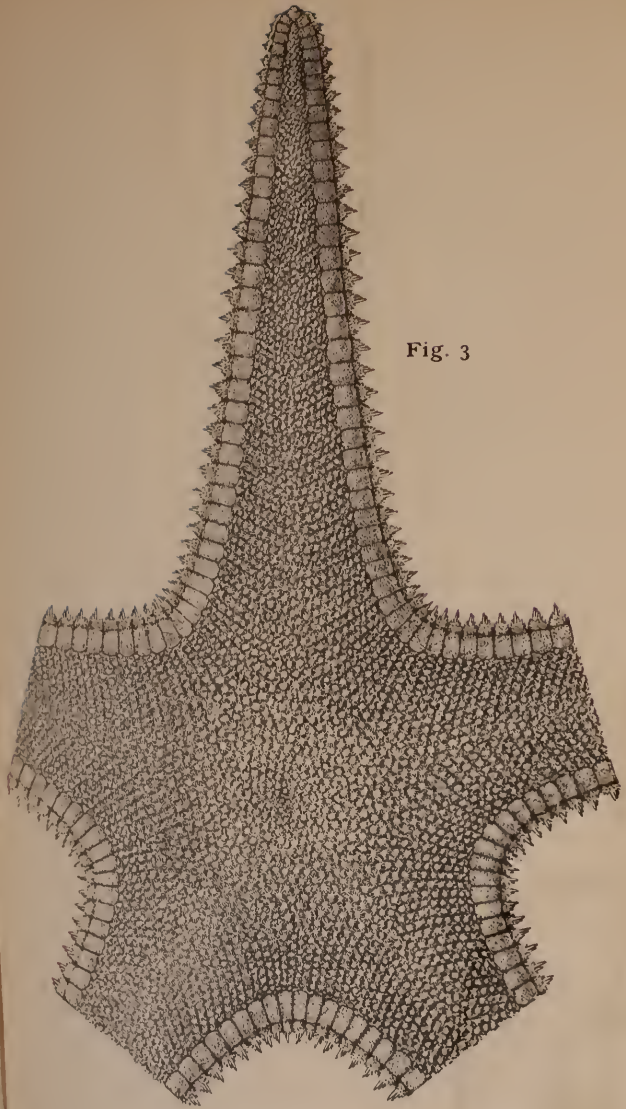

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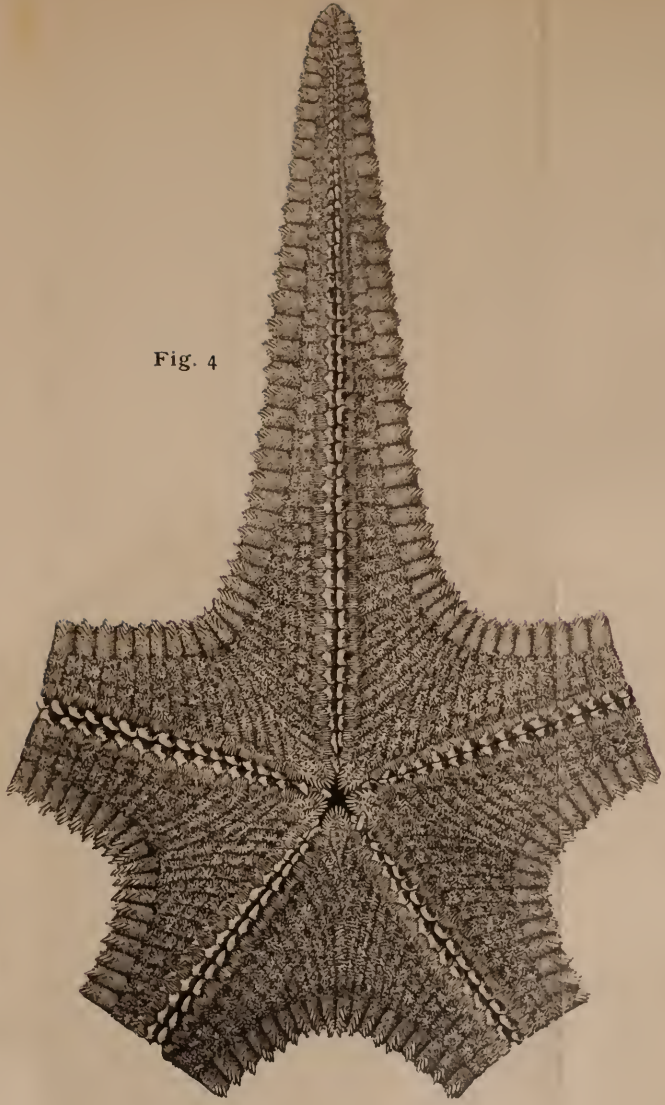
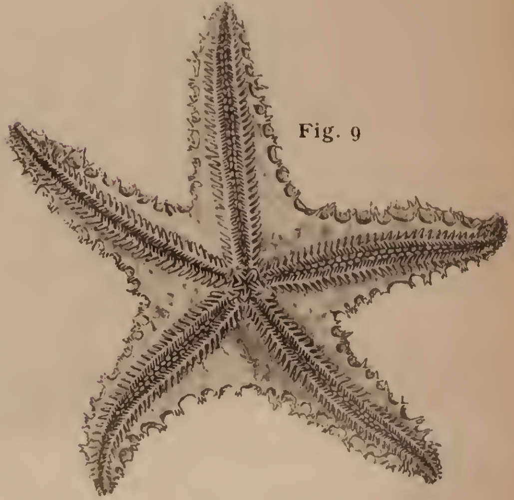


DIPSACASTER SLADENI. ACTINAL SURFACE.

Fig. 8

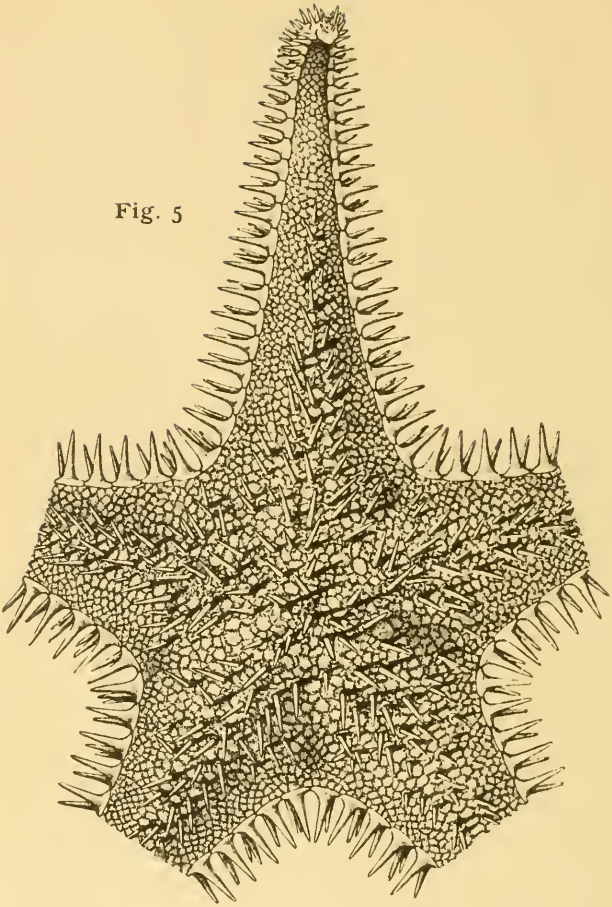
DICTYASTER XENOPHILUS.
ABACTINAL SURFACE

Fig. 9



DICTYASTER XENOPHILUS.
ACTINAL SURFACE.

Fig. 5



MILTELIPHASTER WOOD-MASONI.
ABACTINAL VIEW.

Fig. 7

IPHASTER WOOD-MASONI.
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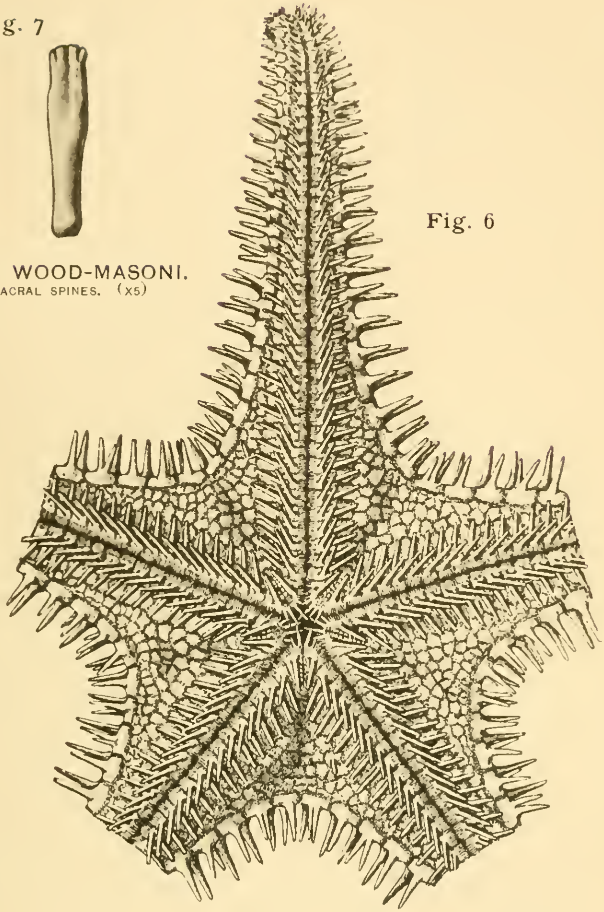
Fig. 6



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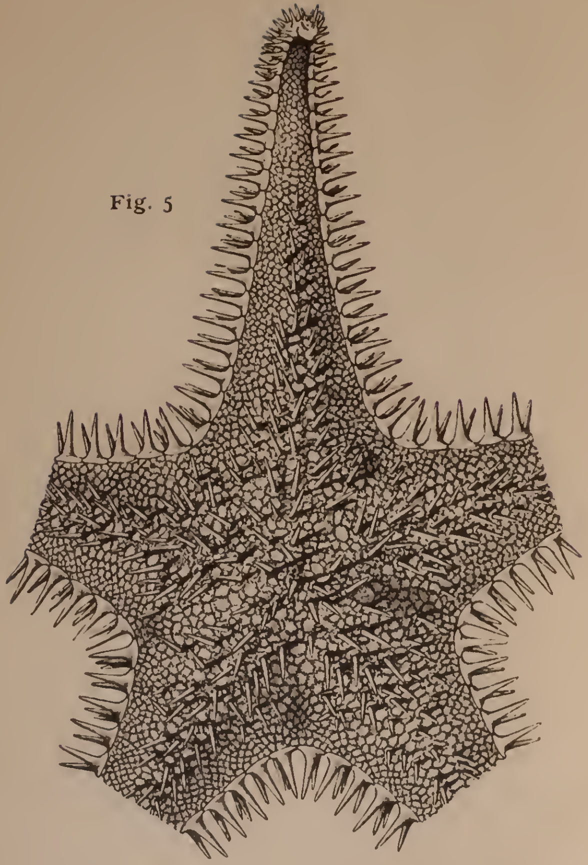
ACTINAL VIEW.

Fig. 5

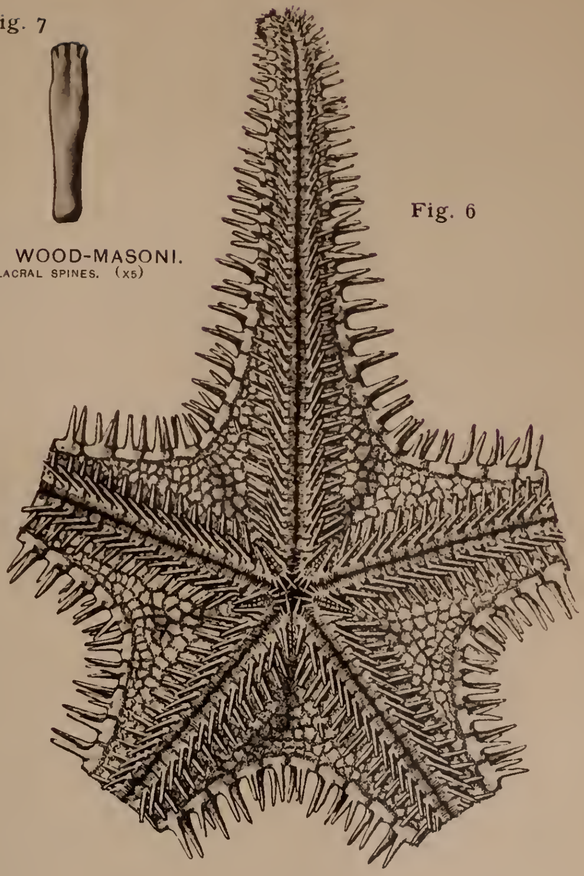


MILTELIPHASTER WOOD-MASONI.
ABACTINAL VIEW.

Fig. 7

MILTELIPHASTER WOOD-MASONI.
ONE OF THE ADAMBULACRAL SPINES. (x5)

Fig. 6



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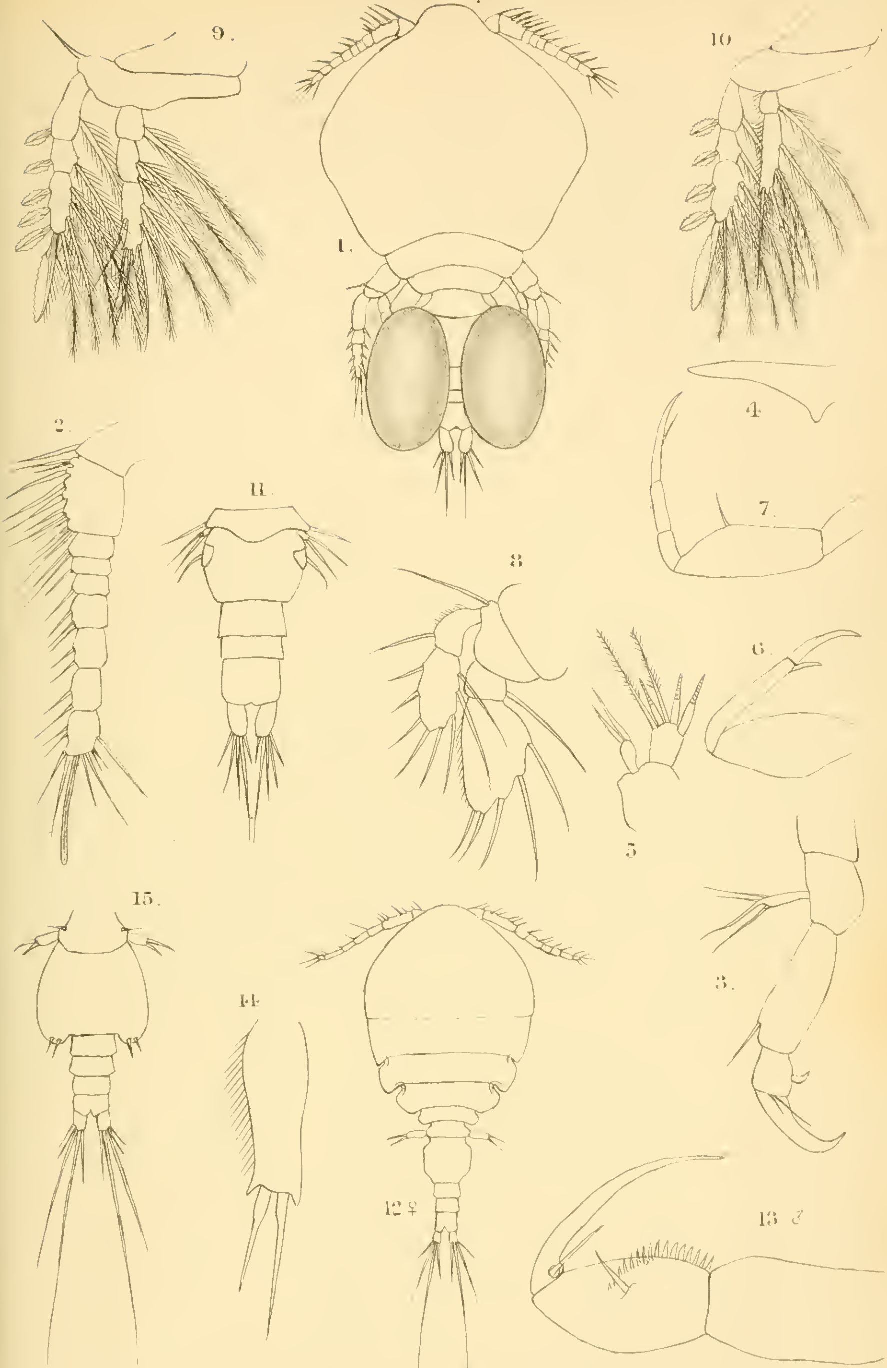

Andrew Scott del.
Mintern Bros. lith.

1-11. PARARTOTROGUS RICHARDI, *n. sp.*
12-15. LICHOMOLGUS CONCINNUS, *Scott*

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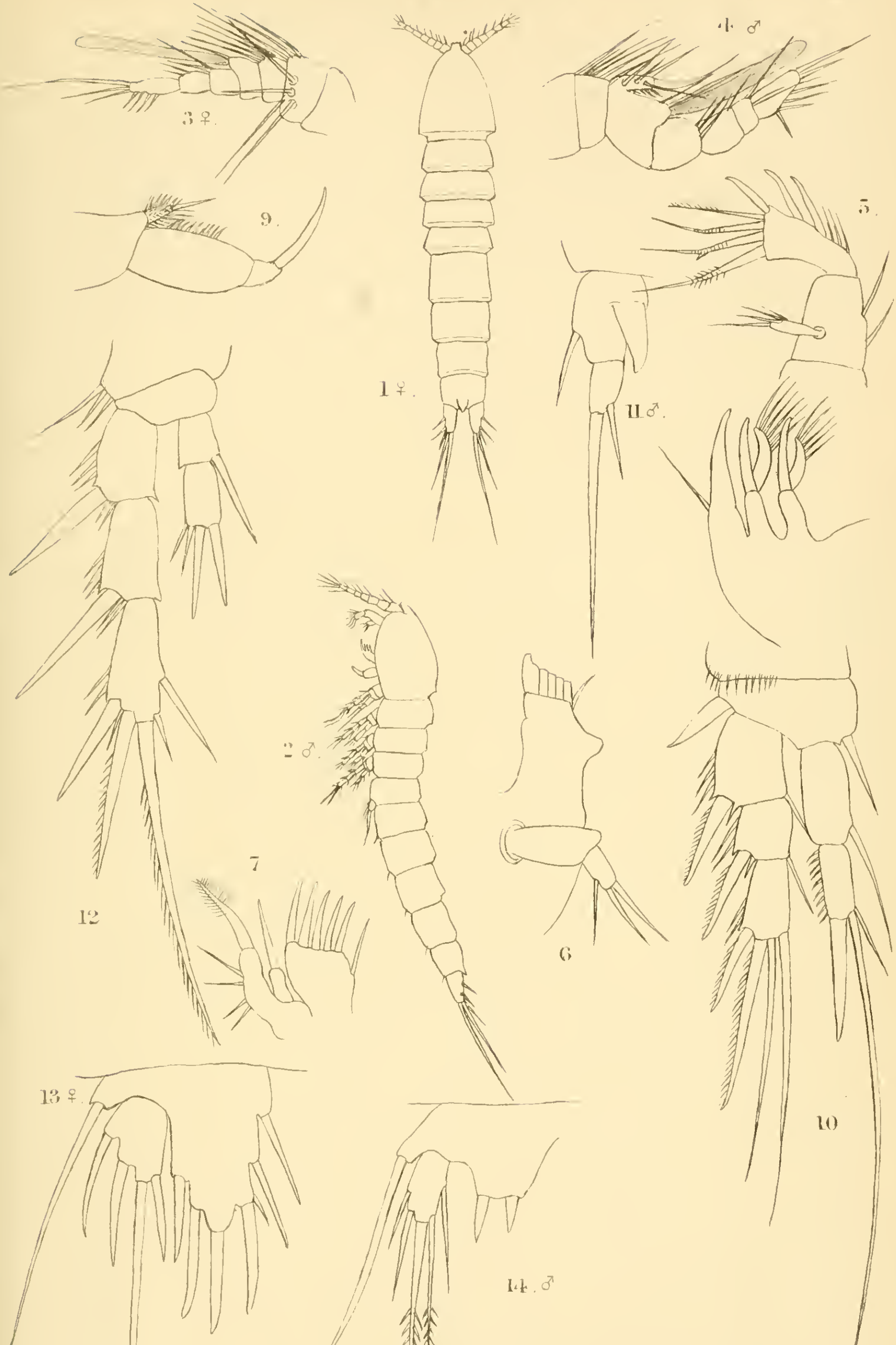

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MORARIA ANDERSON SMITHI, *n. sp.*

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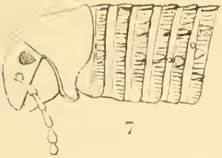
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7b


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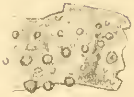
3a.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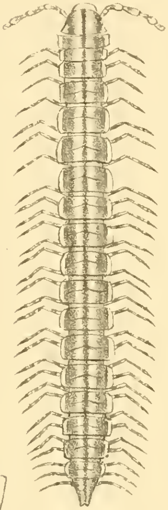
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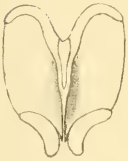
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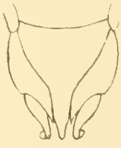
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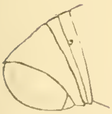
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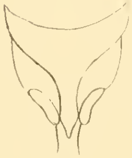
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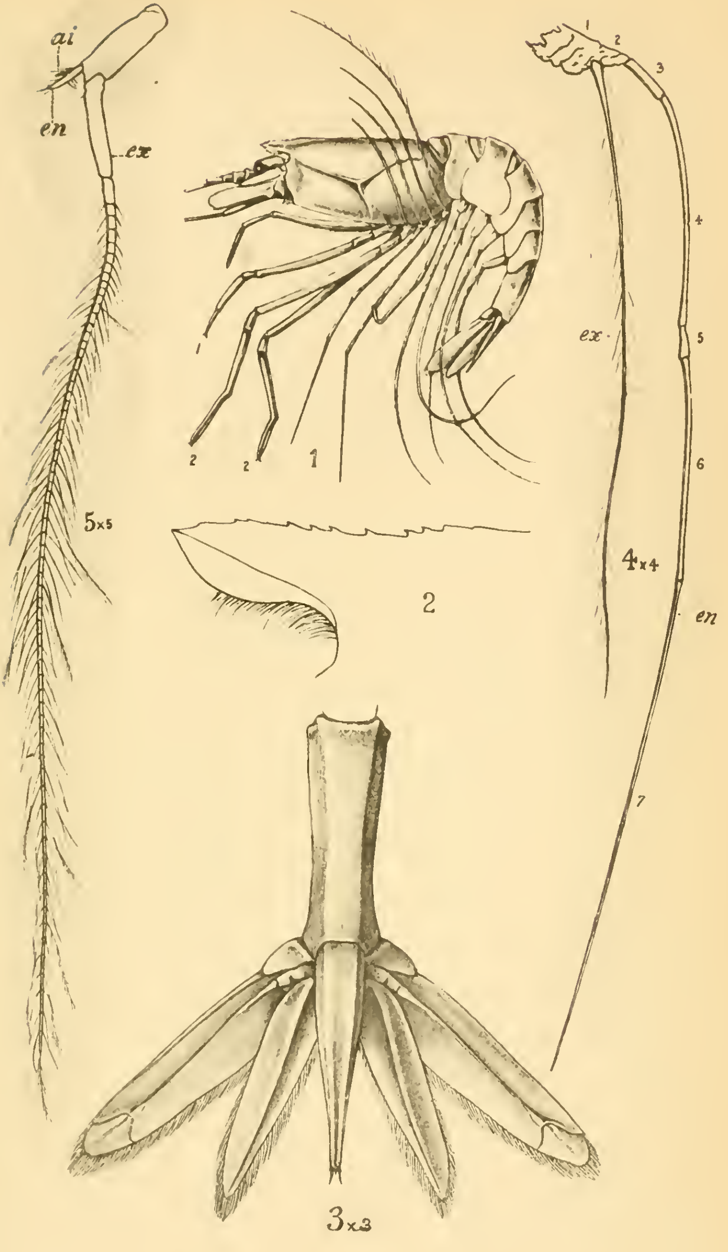

PSATHYROCARIS FRAGILIS.

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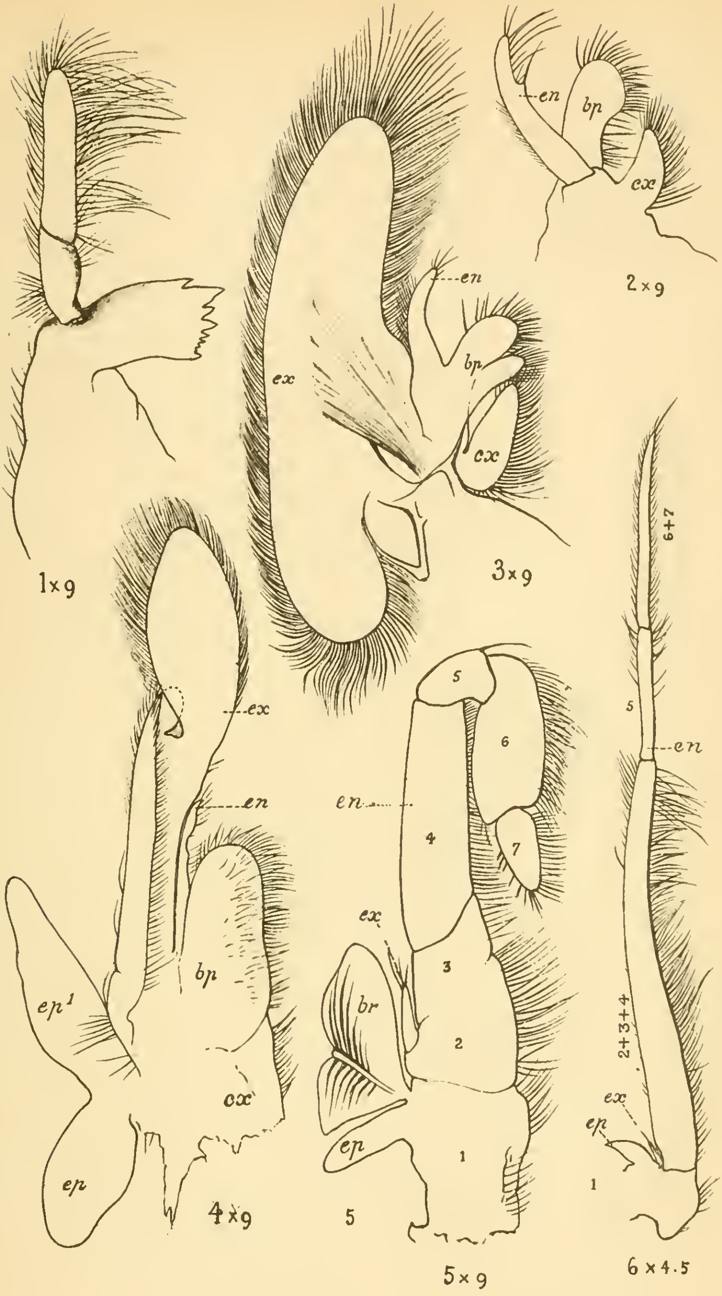

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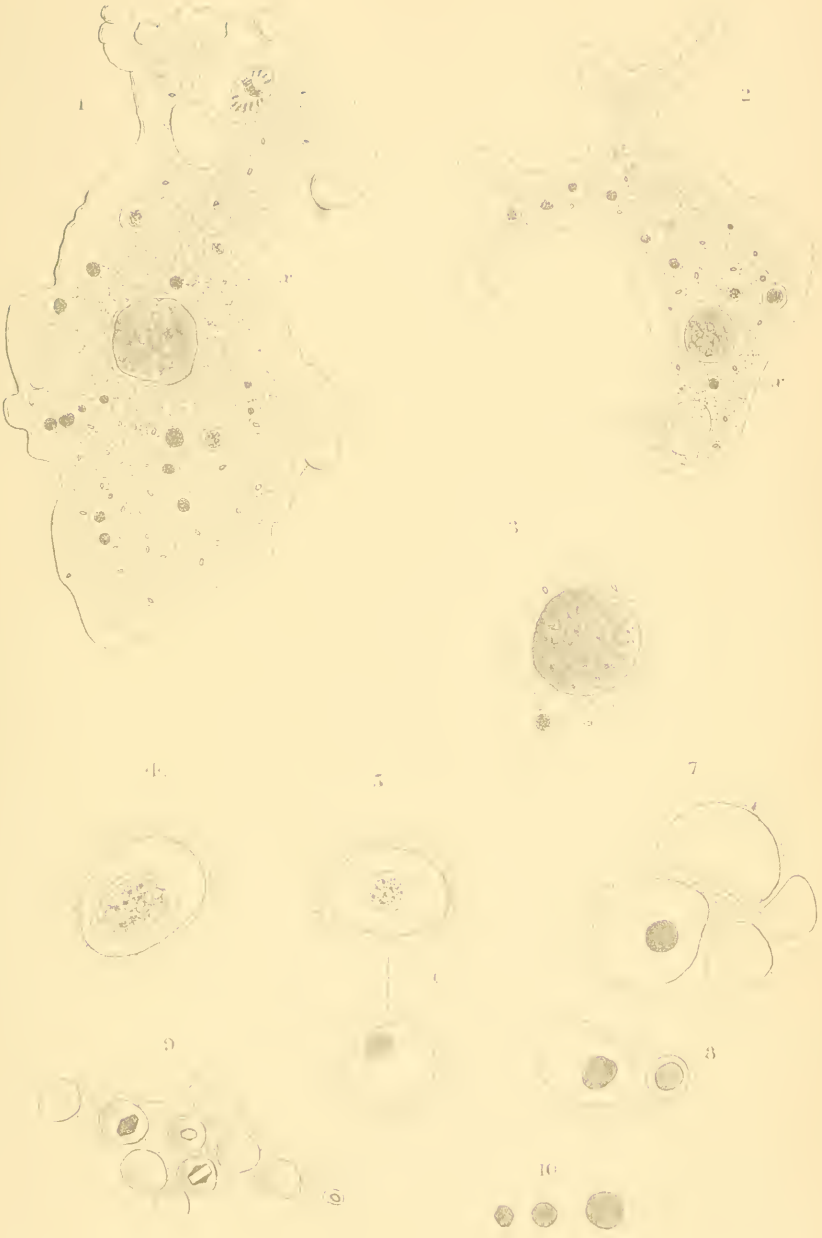

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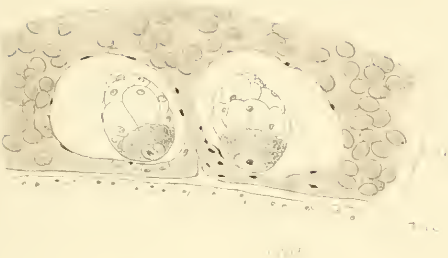

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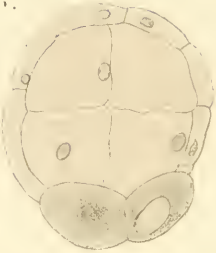

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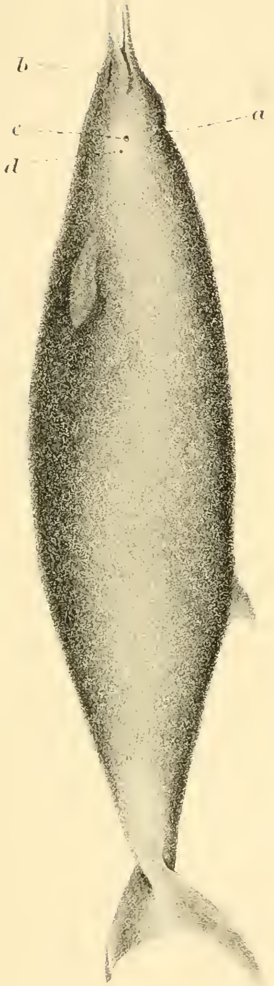

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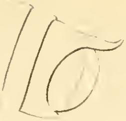
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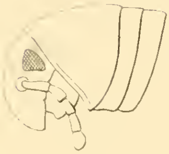
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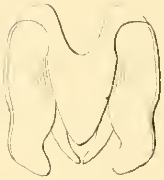
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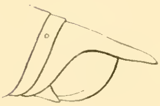
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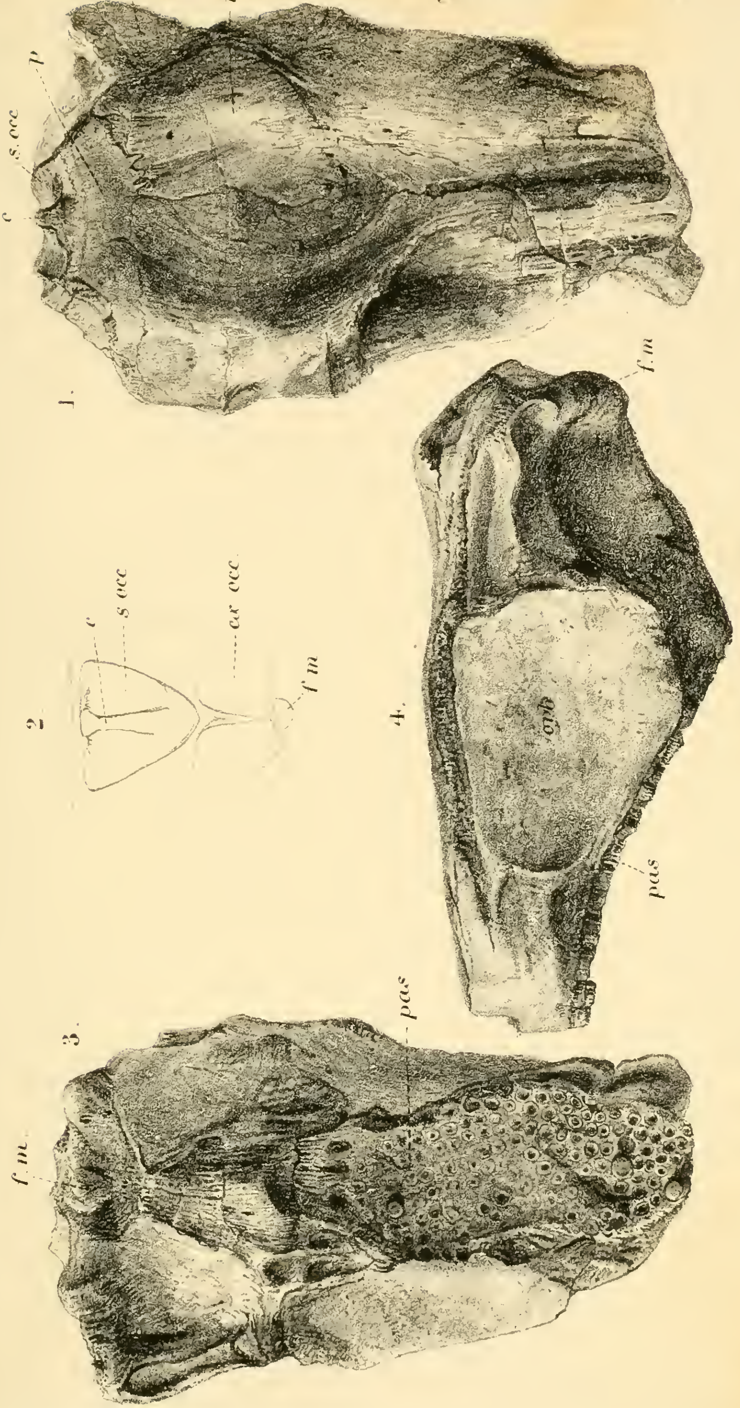
6a


6b.

R. I. P. del.

Mintern Bros. lith.

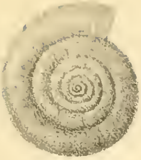


PISODUS OWENI

R Mintern del. et lith.

Mintern Bros. imp.

Ann. & Mag. Nat. Hist. S. 6. Vol. 11. Pl. XVIII.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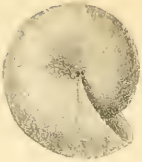
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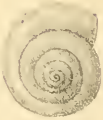
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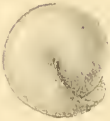
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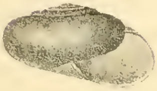
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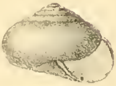
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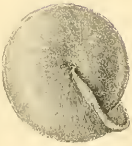
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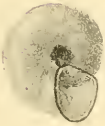
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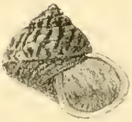

21.


13.

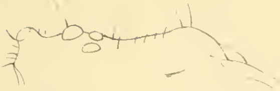

19.

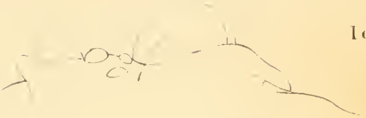
Mintern Bros. del. et lith.

1a

1c

1b.



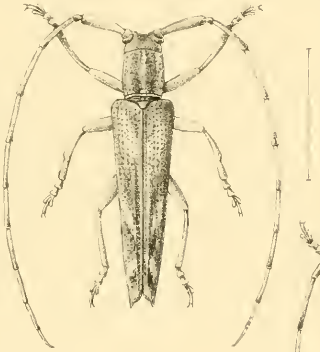


1d.

3.

1

2



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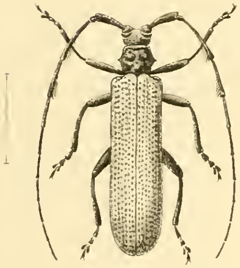

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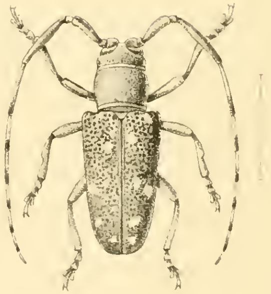

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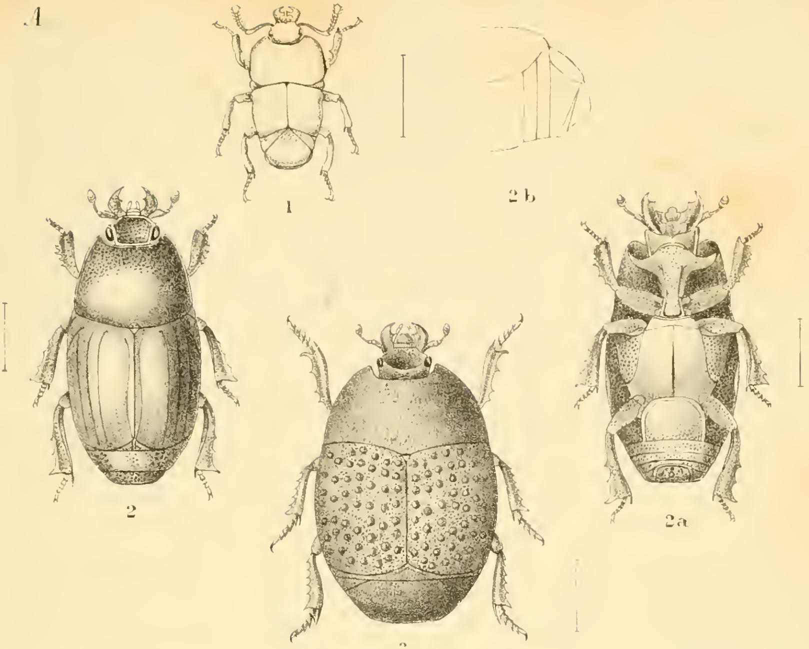
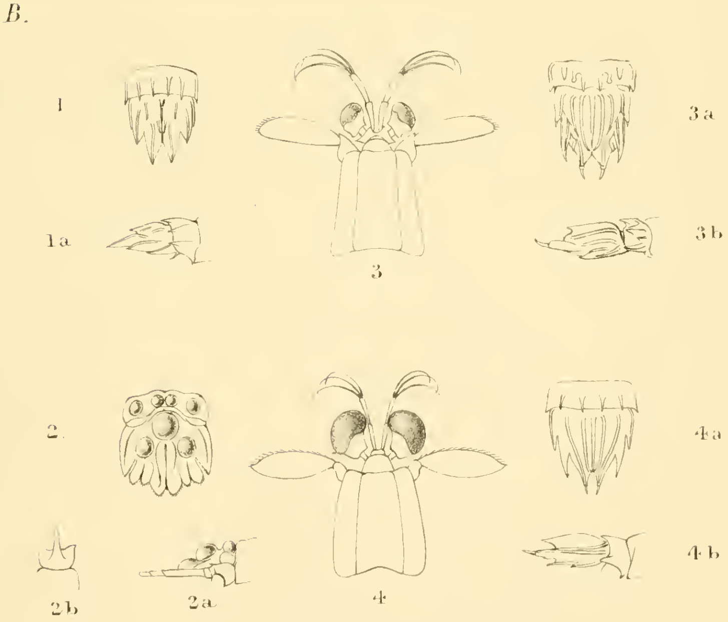
7.

Mintern Bros del. et lith.



M. H. Fisher del



Mintern Bros. lith.