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AND

MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

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

CONDUCTED BY

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

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

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

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

J. TAYLOR, *Norwich*, 1818.

ALERE FLAMMAM.

CONTENTS OF VOL. II.

[FIFTH SERIES.]

NUMBER VII.

NUMBER VIII.

NUMBER IX.

NUMBER X.

NUMBER XI.

NUMBER XII.

PLATES IN VOL. II.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

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

No. 7. JULY 1878.

I.—*On the Genera* Dipterus, *Sedgw. & Murch.*, Palædaphus, *Van Beneden and De Koninck*, Holodus, *Pander*, *and* Cheirodus, *M'Coy*. By R. H. Traquair, M.D., F.G.S., Keeper of the Natural-History Collections in the Museum of Science and Art, Edinburgh.

[Plate III.]

I. Dipterus, Sedgwick and Murchison.

The genus *Dipterus* of Sedgwick and Murchison was classified by Agassiz first in his family of Lépidoïdes*, and afterwards in that of the Sauroïdes Diptériens †, in which latter it was associated with such rhombic-scaled genera as *Osteolepis*, *Diplopterus*, and *Glyptopomus*. In fact Agassiz himself believed that the scales of *Dipterus* were rhomboidal. The cycloidal shape and imbricating arrangement of its scales, however, were pointed out by M'Coy ‡, who accordingly placed it among the "Cœlacanthi" (*i. e.* cycliferous Crossopterygii according to modern ideas), and also doubted the propriety of separating *Glyptolepis* from it, although the very peculiar dentition of *Dipterus* had been already discovered by Hugh Miller §. But the incorrectness of M'Coy's ideas upon this latter point was immediately afterwards

* 'Poissons Fossiles,' vol. ii. pt. 1, pp. 3 and 112.
† 'Poissons Fossiles du vieux Grès Rouge,' pp. 47, 49, and 58.
‡ 'British Palæozoic Fossils,' pp. 590–593.
§ 'Witness' Newspaper, Dec. 23, 1848; 'Footprints of the Creator,' Edinburgh, 1850.

shown by Pander *, who gave an excellent account of the structure of *Dipterus*, and proposed to institute for it the new family of Ctenodipterini, a term afterwards altered by Sir Philip Grey-Egerton into Ctenododipterini †. This family, in which *Ceratodus* ‡ and *Cheirodus* were also provisionally included, was accepted by Prof. Huxley, and placed by him in his suborder Crossopterygidæ §. Moreover, in a remarkable and oft-quoted passage, he drew attention to the singular relations subsisting between the living *Protopterus* and the cycliferous Crossopterygidæ, especially as regards those of the latter which have acutely lobate paired fins. Though Prof. Huxley did not class the Dipnoi as Ganoids, nor *Dipterus* as a Dipnoan, he struck the keynote to its real position in the sentence :—" Furthermore *Lepidosiren* is the only fish whose teeth are comparable in form and arrangement to those of *Dipterus*."

The discovery of *Ceratodus Forsteri* in the rivers of Queensland, and its addition to the catalogue of living Dipnoi, threw a fresh flood of light on the subject; and Dr. Günther was not long in following up the idea suggested in Prof. Huxley's remark quoted above. Guided chiefly by the obvious similarity in *Dipterus* and *Ceratodus* of the bones of the lower aspect of the skull and of the mandible, the dentition, the want of distinct maxillary and præmaxillary elements, the position of the nasal apertures, the notochordal vertebral axis, the acutely lobate condition of the paired fins, and the cycloidal scales, Günther proposed to actually include the Ctenododipterini as a family of Dipnoi, looking upon these Dipnoi, however, not as a distinct order of fishes, but merely as a "suborder" of the Ganoidei. On the other hand the leading differences between *Dipterus* and *Ceratodus*, as indicated by Günther, may be summarized as follows :—the heterocercy of the former genus, its dorsal fin being divided into two, the enamelled surface of its scales, the enamelled scutes of its cranial buckler, its gular plates, the dermal rays of the median fins being joined to the *extremities* of the interneural and interhæmal spines, the latter being branched at their distal ends, and, finally, some unessential differences in the microscopic structure of the dental plates. Yet, "weighing the points of affinity and difference against each other," Dr. Günther observes, "we must come

* 'Ueber die Ctenodipterinen des devonischen Systems,' St. Petersburg, 1858.

† Dec. Geol. Survey, x. 1861, p. 55.

‡ Beyrich had, indeed, previously noticed the resemblance between the dental plates of *Dipterus* and *Ceratodus* ('Zeitschrift der deutschen geolog. Gesellsch.' 1850, p. 154).

§ Dec. Geol. Survey, x. 1861.

to the conclusion that *Dipterus* has a better right to be associated with the living Dipnoi than with *Polypterus*" *.

Prof. Huxley, however, in his recent and very valuable paper on *Ceratodus*, takes a different view of the matter †. In this paper Prof. Huxley performs the great service to science of pointing out that in their "autostylic" skull the Dipnoi differ essentially from the Ganoidei, which are "hyostylic;" and in reference to Dr. Günther's proposed classification he concludes "that it is better to retain the Müllerian groups of Dipnoi (Sirenoidei, Müller), Ganoidei, Teleostei, Plagiostomi, and Chimæroidei (Holocephali, Müller) as equivalent and distinct natural assemblages." And as regards *Dipterus*, he seems to consider that its place is with the Ganoids, saying concerning it, "But even *Dipterus*, which approaches *Ceratodus* and *Lepidosiren* so closely in its dentition and in the form of its fins, is far more similar to *Polypterus* and *Amia* in other respects; and there is at present no reason to believe that any of the Crossopterygian Ganoids possessed other than a hyostylic skull, or differed from *Polypterus* in those respects in which *Polypterus* differs from the existing Dipnoi. All known Crossopterygians have jugular plates, of which there is no trace in the Dipnoi. And as to the position of the anterior nares, which appear to have been situated on the under face of the broad snout, not only in *Dipterus*, but in *Osteolepis* and *Diplopterus*, I have shown above that, so far from being a diagnostic character of the Dipnoi, it is simply an embryonic feature retained in them, the Selachians, and very probably in many of the earlier Ganoidei."

In a recently published memoir on *Ceratodus* ‡, Mr. L. C. Miall follows Dr. Günther in classifying *Ceratodus* and *Lepidosiren* with the Ganoidei; and as regards the special affinities of the Ctenododipterini, the following statements made by him may be quoted:—

"We do not know for certain that *Dipterus* and *Ctenodus* are hyostylic; but the suggestion has a certain degree of probability." But in a footnote appended to this passage he states, "The fossil suspensorium of *Dipterus*, marked xvi$\frac{2}{7}$, in the Museum of Practical Geology seems to show that this genus agrees with *Ceratodus* rather than with *Polypterus* in the mode of suspension of the mandible; but a fuller discus-

* "Description of *Ceratodus*," Phil. Trans. 1871.

† Proc. Zool. Soc. London, 1876, p. 57.

‡ "On the Genus *Ceratodus*, with special reference to the fossil teeth found at Maledi, Central India," Palæont. Ind. ser. iv. 2, Calcutta, 1878. See also the same writer's memoir on the "Sirenoid and Crossopterygian Ganoids," Palæontograph. Society, Lond. 1878.

sion of this point must be reserved for a more suitable occasion. I have seen no specimens of *Ctenodus* which throw light upon the question." However, a little further on he says again, "It is not known whether *Dipterus* and *Ctenodus* are hyostylic or autostylic; but *Polypterus* is hyostylic. It is not known whether *Dipterus* and *Ctenodus* have an archipterygium or an ichthyopterygium; but the outward resemblance of the fins of *Dipterus* to those of *Ceratodus* renders it probable that they have an archipterygium." And in summarizing the arguments for and against the near alliance of the Dipnoi with *Dipterus* and *Ctenodus*, after adducing on one side certain points of agreement, he gives on the other the following as points of difference:—

A. *Lepidosiren*, *Protopterus*, *Ceratodus*. "Autostylic; no gular plates; archipterygium; diphycercal."

B. *Dipterus*, *Ctenodus*. "Hyostylic?; gular plates; archipterygium?; heterocercal (*Dipterus*)."

Finally, he is "inclined to hold that on the whole A and B are not ordinarily separable, but that they represent two families or suborders of Ganoids, which may continue to be called Sirenoidei (Dipnoi) and Ctenododipterini."

That *Ceratodus* and *Dipterus* represent two perfectly distinct "*families*" has, however, been already amply shown by Dr. Günther; the real question is whether or not these two families ought to be classed in the same "order" or "suborder." Do we, with Johannes Müller and Prof. Huxley, consider the Dipnoi and Ganoidei independent "orders" of fishes? If so, are *Dipterus* and *Ctenodus* Dipnoans, or are they Ganoids? If, on the other hand, we look upon the Dipnoi as being merely a "suborder" of the Ganoidei, does the Ctenododipterine family belong to that suborder or to the Crossopterygii, or does it likewise constitute an independent "suborder" by itself?

Whatever value may be placed upon the position of the nasal apertures, it appeared to me, at the time Dr. Günther's paper was published, that his reasoning as to the position of *Dipterus* was irresistible, whether we agree with him in considering the Dipnoi a mere suborder of the Ganoidei or not. In view, therefore, of recently expressed doubts, it becomes of some importance to ascertain whether the extraordinary similarity between *Ceratodus* and *Dipterus* in the form and arrangement of the dental plates and palato-pterygoid bones be not (as might be expected to be the case) accompanied by other important correspondences in the general structure of the head, and more especially whether the skull of *Dipterus* presents that same "autostylic" character, which Prof. Huxley considers, and I think rightly, to be a feature of ordinal value. Having myself dissected *Ceratodus Forsteri* and also very carefully examined the extensive series of specimens of *Dipterus* contained in the Edinburgh Museum of Science and Art, I may now bring forward a few facts bearing on this question, as well as also point out several errors of detail into which Pander seems to have slipped in his justly celebrated memoir on the Ctenododipterini.

It may be readily seen, on examining a series of skulls of *Dipterus* from the Thurso flagstones (see Pl. III. fig. 1), that the chondrocranium was very much more extensively ossified than that of *Ceratodus*; in fact its side walls were entirely occupied by bone apparently as far as the interorbital region. Posteriorly the bony substance of the occiput shows two openings, one above the other. The lower one (*n.ch*), preserving its neatly rounded contour, is for the entrance of the anterior extremity of the notochord into the base of the skull; while the upper (*f. m*), always more or less distorted by crushing, is the *foramen magnum*, for the exit of the spinal cord. The bony matter surrounding these two openings may be held to represent the exoccipitals; and in front of it on each side the walls of the otic region are distinctly ossified—though, from the abraded condition of this part in all the skulls, it is hardly possible to trace any sutural lines marking off distinct osseous elements. The side walls of the cranium now pass gently outwards into a projecting wing on each side, this wing presenting in front a transverse margin and externally a prominent angle, and, allowing for the vertical flattening to which all the specimens showing the base of the skull have been subjected, it must have passed considerably downwards as well as upwards. Its upper surface, displayed in some specimens, and in them seen to be gently concave, must have been covered by the mandibular muscle, roofed over in turn by the plates of the external cranial buckler. Its anterior margin shows, just within the outer angle, a facet (x) for the articulation of the mandible, internal to which the palato-pterygoid plate (*pt*) fits closely on, overlapping also a considerable portion of its under surface. This portion of the skull is clearly to be considered as "quadrate;" and, though it was in all probability ossified from its own centre, no very distinct line of demarcation can be traced between it and the osseous covering of the otic region behind; much less is there any trace of a joint. I have never found it as a detached bone; nor have I seen it wanting in any specimen showing the base of the skull, save in one, evidently long exposed to the action of the sea, and in which, apparently by continued weathering, and not as the fossil was originally entombed, *every thing else* has also been removed, save the two palato-pterygoid plates, which are left still adhering to the under surface of the external buckler. In fact we have here before us as nearly as possible a counterpart in bone of the suspensorial portion of the cranial cartilage of *Ceratodus*; and that the one was as inseparable a part of the skull as the other is evident on the face of things, even although it is naturally impossible to demonstrate any continuity of original cartilage in the fossil skull.

The suspensorium of *Dipterus* is therefore *autostylic*, and closely resembles in form and relations that of *Ceratodus*, from which it mainly differs in being so extensively ossified.

A comparison of Pander's figures 12 and 13 on plate iii. of his work with a series of well-preserved specimens shows that, misled by accidental fractures, he has dismembered the quadrate of *Dipterus* into two parts, which he calls respectively "pterygoideum externum" and "quadrato-jugale."

In perfect harmony with the condition of the suspensorium we also find that of the palato-pterygoid plates (*pt*, Pl. III. fig. 1). Their relations to each other and to the base of the skull are precisely the same as in *Ceratodus*; and in their external form they are also very similar to those of that living genus. Their anterior portions, bearing the dental plates, are firmly sutured to each other in the middle line; their hinder portions diverge backwards and outwards, separated by the anterior part of the parasphenoid, with which they are also immovably articulated; their posterior extremities overlap the lower aspect of the quadrate. In the skull represented in fig. 1 a slight twist, which the specimen has undergone through crushing, has dislocated the left palato-pterygoid a little backwards and inwards from its position with respect to the quadrate; but its connexions with its fellow and with the parasphenoid have remained as firm as ever.

By Pander each palato-pterygoid is represented as consisting of two portions, "os palatinum" and "os pterygoideum internum," separated by a longitudinal suture or groove; and this or a similar statement has been frequently made by other writers, who have found in the supposed suture or groove a point in which *Dipterus* differs as well from the Carboniferous *Ctenodus* as from *Ceratodus**. The examination, however, of

* Hancock and Atthey, Ann. & Mag. Nat. Hist. (4) vii. 1871, pp. 190–198; Günther, Phil. Trans. 1871, p. 556; W. J. Barkas "On the Dentary, Articular, and Pterygo-palatine Bones of *Ctenodus*," Proc. Roy. Soc. of New South Wales, 1876; Miall, Quart. Journ. Geol. Soc. Dec. 1874, p. 774.

a large series of specimens reveals the fact that no such suture or groove, indicating an original division of the bone, exists, and that the distinguished Russian palæontologist has again been misled by accidental fractures. This is particularly evident in his figure 13, tab. iii.; and as regards his figure 12 in the same plate, in none of the numerous specimens before me can I see any thing at all resembling the straight deeply indented sutural line which is there represented as dividing the posterior diverging part of the palato-pterygoid into two longitudinal halves. The palato-pterygoid of *Dipterus* consists, then, as in *Ceratodus* and in *Ctenodus*, only of one bone; and the peculiarity supposed to be characteristic of the first-named genus therefore falls to the ground. A completely isolated example of this bone is preserved in the Hugh-Miller collection, and is figured in the 'Footprints of the Creator.'

The same remarkable correspondence between *Dipterus* and *Ceratodus* is seen in the structure and configuration of the mandible (Pl. III. figs. 2, 3, and 4); but here also we find that in the Devonian genus ossification is more extensive, and, in addition, a ganoid surface is extensively developed on its outer aspect. The articular element (*ar*), in *Ceratodus* not differentiated from the Meckelian cartilage, is well ossified, and presents posteriorly, and looking upwards and backwards, a deep rounded notch for articulation with the quadrate. Externally and internally the articular is embraced between the posterior extremities of the splenial (*sp*) and of the bone termed in *Ceratodus* "articular" by Dr. Günther, "angular" by Prof. Huxley. The latter element (*ag*) has the same relations as in *Ceratodus*, covering as it does the greater part of the outer surface of the ramus, and passing above and behind into a coronoid process. At the posterior extremity of its lower margin there is, in every specimen I have seen, an appearance as if a small additional piece had fitted on just below the angle of the jaw; but as such an additional piece has not occurred *in situ*, its presence cannot be affirmed. The splenial (*sp*), carrying the mandibular dental plate, is extremely similar in shape, and identical in its relations with that of *Ceratodus*: its anterior extremity, covered up by the matrix in the specimen represented in fig. 2, but visible in other examples; curves inwards and meets its fellow at the symphysis; so close is the union that I have not clearly detected any suture between them. The front of the mandible presents a shovel-shaped aspect, reminding us at once of that of *Ceratodus*; but whereas in *Ceratodus* the labial margin is formed by a shovel-shaped expansion of the coalesced Meckelian cartilages, and the right and left pieces of bone, considered by Prof. Huxley to represent the *dentary* elements, are small, seen principally on the lower aspect of the jaw, and separated from each other by a median suture, we have in *Dipterus* a single bone (*d*), on whose external smooth and ganoid surface no median suture can be seen, and which, extending upwards and forwards, forms a rounded enamelled lower lip, whose contour, as seen from above (fig. 2), constitutes an arc of more than half a circle. Seen from below (fig. 3) this median "dentary" shows posteriorly a free concave border, continuing the lower margins of the right and left rami uninterruptedly round into each other; in front it passes round into the labial margin already mentioned. The oral aspect of the bone, just within the lip and above the united splenials, is, in one specimen, seen to possess a narrow band of small enamelled denticles, resembling in form those on the ridges of the palatal and splenial dental plates, but irregularly arranged; in fig. 2 these are concealed by the matrix. Now if we look at the jaw from the side (fig. 4)—and the same appearance is also to some extent visible from below (fig. 3)—it will be seen that below the posterior half of the labial margin the bone is suddenly and deeply excavated, so as to form on each side a well-marked hollow (*y*), bounded below by a sharp margin, which, curving sharply round in front, passes then into the posterior part of the lower lip, overhanging and bounding the hollow from above. Posteriorly the floor of this hollow, which is non-ganoid and crossed obliquely by the suture separating the dentary from the angular element, passes uninterruptedly backwards onto the outer surface of the latter. These hollows are important, inasmuch as they afford us an explanation of the real nature of the so-called nasal apertures of *Palædaphus insignis* (figs. 5, 6, 7), as we shall see in considering that remarkable fossil further on.

The large lozenge-shaped *parasphenoid* of *Dipterus* (fig. 1, Pl. III. *pa.sph*) is well known; and its relations to the palatopterygoid plates are precisely as in *Ceratodus*; there is, however, no evidence of its having been prolonged backwards as a narrow process along the under surface of the vertebral axis for a little distance behind the skull as in the latter genus. The "palatal dart-head," figured by Hugh Miller ('Footprints of the Creator') is the anterior part of the parasphenoid broken off.

The upper aspect of the skull differs remarkably from that of *Ceratodus* in being covered by a buckler of thick polygonal ganoid plates, whose arrangement has been well delineated by Hugh Miller and by Pander, though it is difficult to trace any exact correspondence between them and the cranial roof-bones of ordinary Ganoids and Teleostei. Anteriorly, at the broad depressed snout, sutures cease to be traceable in this bony and ganoid covering, which, becoming reflected round the oral margin, forms a rounded upper lip, overhanging the corresponding mandibular lip when the mouth is closed, as is seen in one specimen in the Hugh-Miller collection. Looking at this lip from the lower aspect of the cranium (Pl. III. fig. 1), the reflected bony covering shows on each side two wide notches, anterior and posterior (*n* and *n'*), which certainly indicate the position of the nasal openings and show that these were placed just as in *Ceratodus*, as has been already pointed out by Dr. Günther. There is no distinctly differentiated maxilla or præmaxilla; but the cheek is covered by an arrangement of bony plates, which encircle the orbit and inferiorly continue the upper margin of the mouth for a little distance backwards from the nasal margin of the snout, these plates being represented in *Ceratodus* only by the chain of small suborbital ossicles imbedded in the firm fibrous band below the eye*.

The opercular bones of *Dipterus* correspond in number and position with those of *Ceratodus*, but differ in being of a broader and rounder shape, and, of course, in having ganoid surfaces. There is a large *operculum*, below which there is a much narrower plate corresponding to that bone which in *Ceratodus* is interpreted by Prof. Huxley as *interoperculum*; but I have seen nothing which can be taken to represent a præoperculum, though Pander has figured a plate which he supposed might represent that element. The *jugular plates* are obvious, and seem to have existed as *two pairs*, anterior and posterior; but I have not seen the median plate figured by Pander (*op. cit.* tab. 1. figs. 9*a*, 23).

The bones of the shoulder-girdle correspond closely with those of *Ceratodus*. There is a broad supraclavicular, proceeding backwards and a little downwards from the posterior part

* With regard to the suborbitals of *Ceratodus*, it may here be appropriate to correct a somewhat serious error which occurs in Mr. L. C. Miall's figure of the skull of *C. Forsteri* (Sirenoid and Crossopt. Ganoids, pl. 1 A. fig. 2). The suborbitals are not figured; nor are they mentioned in the text; but the cheek is represented as covered by a large plate of *cartilage*, in which a circular hole for the orbit is, as it were, punched out; and in the explanation to fig. 3 of the same plate (in which the cartilage is represented as cut away to afford a side view of the palato-pterygoid and its dental plate) it is said that "the lateral cartilages are largely removed." Now this "lateral" circumorbital cartilage (or "cartilages") simply *does not exist*; and I have myself, on the contrary, completely verified Prof. Huxley's statement as to the suborbital fibrous band and osseous chain; only in my specimen I find five such ossicles, instead of three as given by Prof. Huxley.

of the skull and overlapped by the operculum. This is succeeded by a clavicle, whose direction is first downwards and then somewhat forwards. The lower part, forming an obtuse angle with the upper, is formed, as in *Ceratodus*, of a distinct piece, divided off from the upper by a suture which passes just below and in front of the attachment of the pectoral fin, and may be regarded as the equivalent of the *infraclavicular* bone in Crossopterygii and Acipenseroidei.

The points of resemblance between *Dipterus* and *Ceratodus* certainly do not stop when we come to the paired fins, which, *so far as their structure is preserved* in the former genus, are similarly conformed in both. There is, in *Dipterus*, a central elongated and pointed scaly axis, fringed, both preaxially and postaxially, with a series of delicate fin-rays. In no case is the internal skeleton preserved; hence we may truly infer that, as in *Ceratodus*, it was cartilaginous; and I cannot conceive of any reasonable doubt as to its having been also archipterygial in its nature. Mr. L. C. Miall, who seems to entertain doubts on this point, says that "the presence or absence of scales upon the fin does not mean much," though in another passage already quoted he thinks it "probable" that *Dipterus* and *Ctenodus* have an archipterygium. The question is not, however, one of the presence or absence of scales upon a fin, but of the arrangement of the rays. In many specimens of *Dipterus* the covering of scales upon the axial "lobe" of the pectoral and ventral members is so delicate and thin that the rays stand out boldly defined for their entire length, the pre- and postaxial series enclosing between them an elongated pointed space, which it is as reasonable to conclude was once occupied by a cartilaginous skeleton as that the orbit of a fossil fish once contained an eye with lens and retina. And as in the only recent form (*Ceratodus*) in which the rays have that remarkable arrangement this skeleton is archipterygial, we are scarcely chargeable with rashness in believing that this also was the case in *Dipterus*.

The vertebral axis was in *Dipterus* certainly notochordal, as shown by numerous specimens in the Edinburgh Museum; and from what is seen of its ribs, vertebral apophyses, and interspinous bones or fin-supports, they were conformed and arranged much as in *Ceratodus*. Pander, indeed, described and figured certain detached vertebral bodies which he doubtfully assigned to *Dipterus*; but all the evidence is to the contrary. In many specimens, however, as has been already noted by Pander, there is to be seen in the body-axis, in the region of the caudal fin, a raised line of a somewhat beaded appearance, which may be explicable by a reference to the condition of the tail in *Protopterus* and at least some specimens of *Ceratodus**. Here the notochord stops short before reaching the extremity of the tail, and the bases of the vertebral arches, which have been proportionately increasing in depth, meet each other from above and fuse together, each neural one with the corresponding hæmal opposite, so as to produce, as Dr. Günther observes, "*a distinct vertical segmentation*," some amount of ossification in which might, in *Dipterus*, have produced the appearance in question.

The heterocercy of *Dipterus*, and the differentiation from the median fin-system of two dorsals and one anal, distinct from the caudal, are points which can only be looked upon as of "family" importance. Some difference from *Ceratodus* is observable in the structure and arrangement of the median-fin rays, but not to the extent that Dr. Günther has stated. These rays are closely set; but tracing them towards their origins they are seen to converge into small fasciculi, each of which apparently results from the division of an original ray; the rays are also unarticulated up to a certain point, from which they become closely jointed to their terminations. It is quite clear that the unarticulated proximal portions of these rays are what Pander has described as interspinous bones ("Flossenträger"); and, following this interpretation, Dr. Günther has indicated as an important point of distinction between *Ceratodus* and *Dipterus* that the latter has its "interneural and interhæmal spines branched at their distal end, to which the dermal rays are joined." The real fin-ray, however, includes both what is here considered as "ray" and as "interneural" or "interhæmal spines;" and its proximal extremity in reality *overlaps*, as might be expected, the real series of interspinous elements, which, however, are seldom seen, owing to the scaly covering of the body.

As the result of the observations briefly recorded above, I feel myself compelled to differ from Prof. Huxley in his opinion that *Dipterus* is much more similar to *Polypterus* and *Amia* than to the living Dipnoi in other respects than its dentition and the form of its fins—as well as from Mr. Miall, in his statement that "it is not easy to say whether the resemblances or the differences between the Dipnoi and the Ctenododipterini are of greater weight." Agreeing, however, with the last-named author, that "the presence or absence of gular plates is hardly of ordinal value," the correspondence between *Dipterus* and *Ceratodus* in all points of real ordinal

* Günther, *op. cit.* p. 527, pl. xxx. fig. 3.

or subordinal importance is so close as, in my estimation, most fully to justify the step taken eight years ago by Dr. Günther in associating the two genera in one common group (Dipnoi), in which they respectively represent the two distinct *families* of Ctenododipterini and Sirenoidei. In retaining the Dipnoi as a distinct order of fishes I shall continue to follow Prof. Huxley; the discussion of this question is beyond the scope of the present paper.

II. Palædaphus, Van Beneden and De Koninck, *and* Holodus, Pander.

In 1864 a remarkable fossil from a Belgian Palæozoic limestone, formerly supposed to be of Carboniferous age, but now, as I understand from Prof. De Koninck, referred to the Devonian formation, was described and figured by the distinguished palæontologist just named, in conjunction with Prof. Van Beneden, and received from them the name of *Palædaphus insignis**.

The Edinburgh Museum having recently, through the kindness of Prof. De Koninck, acquired a plaster cast of the specimen, I have represented it much reduced in Plate III. figs. 5, 6, and 7. It consists of two rami closely united in front and broken off behind, the left one almost immediately behind the union, the right somewhat further back. The aspect of the fossil shown in fig. 6, considered by its describers to be the *upper* surface of a head, is characterized by them as being "d'une apparence écailleuse et brillante, comme si elle avait été recouverte d'une peau cornée, mais la couche de matière qui lui communique ce brillant est extrêmement mince et assez dure." The other aspect (shown in fig. 5) displays two large dental plates, touching each other in the middle line for some distance in front, and furnished each with four well-marked rounded ridges passing from behind forwards in a slightly radiating manner, there being also a slight appearance of crenulation of these ridges, as seen in the profile view fig. 7. In front of these dental plates, and separated from them by a groove, the anterior margin, gently curved in contour, and thick and rounded, seems formed as if by a folding-over of the opposite surface; on each side the outer extremity of this lip-like margin is abruptly truncated, and presents an excavation (y) bounded above, in front, and below by elevated margins, but posteriorly passing uninterruptedly into a shallow groove which proceeds backwards for some distance along the outer aspect of the fossil (fig. 7).

* Bull. Ac. Belg. (2) xvii. 1864, pp. 143–151. The same fossil is also figured in Gervais's 'Zoologie et Paléontologie françaises,' pl. lxxvii. fig. 17.

By Messrs. Van Beneden and De Koninck this fossil was considered to be the anterior part of the head of a fish which belonged "sans contestation à l'ordre des Plagiostomes et au sous-ordre des Squalidiens." The two dental plates they regarded as the two halves of the upper jaw, the anterior rounded ridge as the upper lip; and, lastly, as regards the two lateral fossæ or excavations (*y*), they considered that they "ont probablement correspondu aux fosses nasales de l'animal." No trace of eyes could, however, be discovered; and, in conclusion, they held that this curious fish approached on the one hand the Chimæroids, on the other the Cestracionts and Squatinids.

Some time afterwards another and apparently closely allied fossil was described by Prof. Van Beneden from the Devonian strata of Belgium *. This consists of a large dental plate closely united along nearly its entire length with its fellow of the opposite side, and presenting fine ridges, anteriorly tuberculated or crenulated, and slightly diverging from each other as they pass from behind forwards. To this specimen Prof. Van Beneden gave the name of *Palædaphus devoniensis*, considering it to be the upper jaw of a Plagiostome of the same genus as that previously described by himself and Prof. De Koninck.

Pander had, however, already, in 1858, described, under the name of *Holodus* †, a fragment from the Devonian of Russia, which, though of much smaller size, bears a most unmistakable resemblance to *Palædaphus insignis*, being, in fact, evidently the very same part of the head of a closely allied animal. On comparing Pander's figure of *Holodus* with those of *Palædaphus insignis* it will be seen that, like the latter, the fragment consists also of two united and diverging rami, broken off close behind their union. On one aspect we have a smooth ganoid surface undivided by any median suture, and reflected over in front so as to form a lip-like margin; on the opposite aspect are two dental plates whose outer margins are elevated and bear each at least two conical tooth-like tubercles; these dental plates do not, however, as in *Palædaphus*, touch each other in the middle line, though the bones on which they are carried are united by median symphysis. Seen from the side, the lip-like margin is truncated as in *P. insignis*, and shows here exactly the same right and left depressions or hollows, supposed in the Belgian fossil to be nasal fossæ.

This fossil (*Holodus*) was also considered by Pander to be the *snout* of a fish; the bones bearing the tooth-plates are compared by him to the palato-pterygoids of *Dipterus*; and into the angle where they diverge posteriorly he conceives an "os

* Bull. Ac. Belg. (2) xxvii. 1869, pp. 378–385.

† 'Ctenodipterinen,' pp. 38–43.

sphenoideum" (parasphenoid) to have been inserted. Finally, though he compares the teeth to those of *Lepidosiren*, he does not seem to consider *Holodus* as a Ctenododipterine, saying that "the remarkable structure of the head, so strikingly different from every thing hitherto known from the older formations, points to a new family, whose dermal coverings, as in the Ctenodipterini, consisted of a bony substance outwardly protected by a kosmine layer."

I have already mentioned that it is clear that *Palædaphus insignis*, v. Ben. and De Kon., and *Holodus Kiprijanowi*, Pander, are closely allied, and represent corresponding parts of the head in the animals to which they respectively belonged; the strongly Ctenododipterine aspect of the dental plates in both cannot fail to strike every observer. But while there is nothing to prevent *Palædaphus devoniensis* from being the palatal tooth-plate of a fish allied to *Dipterus* or *Ctenodus*, the aspect of *P. insignis*, as of *H. Kiprijanowi*, is certainly in many points very unlike that of the snout or "upper jaw" of a fish of that family. So Dr. Günther, in considering what other genera of fossil fishes should accompany *Dipterus* to its new position among the Dipnoi, remarks, "At first I thought that *Holodus*, Pander, was another Dipnoous genus; but I changed this opinion after having compared it with *Palædaphus* of Van Beneden and De Koninck. These two genera are evidently closely allied; and the position of their nostrils (so far as we can judge from the fragmentary remains) appears to have been different from that of the Dipnoi: these openings were more lateral and outside of the mouth. It seems also that there would not have been room for a pair of vomerine teeth, at least not in *Palædaphus*"*.

Prof. J. S. Newberry, however, maintains the Ctenododipterine nature of *Palædaphus devoniensis*, but at the same time considers it to be both generically and ordinally distinct from *P. insignis*. For the former he proposes the generic name *Heliodus*, to include also a new species *H. Lesleyi*, Newb., from the Devonian of North America, retaining the genus *Palædaphus* for *P. insignis*, with whose original describers he agrees in considering it to be probably the head of a large Plagiostome †.

That two forms which in the aspect of their dental plates bear so evident a resemblance to each other and to the Ctenododipterini should be so widely separated as Prof. Newberry supposes, does seem *à priori* a little improbable. A step towards the solution of the problem may, however, be attained by simply asking ourselves the following questions:—Are we

* *Op. cit.* p. 557.

† Palæontology of Ohio, vol. ii. (Columbus, 1875), pp. 62, 63.

quite sure that in *Palædaphus insignis* we have the *snout* or *upper* part of a fish-head? that its dental plates belong to the upper jaw? that the lateral excavations are really *nasal* openings?

The answer to these questions will be found by comparing *Palædaphus insignis* not with the snout, but with the *lower jaw* of *Dipterus.*

The smooth enamelled surface seen in fig. 6 corresponds obviously with the lower aspect of the united dentaries of *Dipterus* shown in fig. 3; and in the cast there is a distinct trace of a suture in a situation analogous to that which in *Dipterus* separates the dentary from the angular behind. The labial margins are very similar, though that of *Dipterus* is more convex in its contour when seen from above or below (figs. 2, 3). The lateral excavations in *Palædaphus insignis* (*y*, figs. 5 & 7) correspond exactly with those below the hinder part of the enamelled lower lip of *Dipterus* (figs. 3, 4), as will be at once apparent on comparing the lateral view of the lower jaw of *Dipterus* (fig. 4) with that of *Palædaphus* (fig. 7); these excavations are therefore *not* nasal openings. The ridged plates supposed to be the halves of the upper jaw of *Palædaphus insignis* represent the splenial dental plates of *Dipterus*, from which they differ in their relatively more anterior position and in coming into contact with each other in front.

There is therefore, in my mind, not the smallest doubt that *Palædaphus insignis* of Van Beneden and De Koninck is the symphysial part of the lower jaw of a gigantic Ctenododipterine fish, and not the snout of a Plagiostome as has been supposed. The same interpretation, size only excepted, must necessarily be accepted for *Holodus Kiprijanowi* of Pander.

Palædaphus devoniensis is evidently the upper or palatal plate of an allied species; there is therefore no necessity for altering its name to *Heliodus*; and if Prof. Newberry's *H. Lesleyi* does belong to the same genus, the name *Heliodus* must drop.

III. Cheirodus, M'Coy.

A small dental plate from the Carboniferous Limestone of Derbyshire was described and figured by M'Coy under the name of *Chirodus pes-ranæ* *, and considered by him to be a tooth of a Selachian allied to *Ceratodus*, which was at that time still reckoned amongst the sharks.

* Ann. & Mag. Nat. Hist. (2) ii. 1848, pp. 130, 131; 'Palæozoic Fossils,' p. 616, pl. 3 *g*. fig. 9. The name is spelt "*Chirodus*" by M'Coy; but, in common with the majority of authors, I prefer the form "*Cheirodus.*"

Other teeth from the Devonian of Russia were subsequently described by Pander as *Cheirodus Jerofejewi*; and from the resemblance which the palatal tooth-plates of this form bore to M'Coy's *Conchodus ostreaformis* from Scat Crag, he proposed to cancel the latter name on the ground that M'Coy had founded it on the palatal tooth-plate of a fish generically identical with that whose mandibular one constituted *Cheirodus pes-ranæ*. *Cheirodus* (incl. *Conchodus*), as well as *Ceratodus*, was placed by Pander provisionally among the Ctenododipterini.

On this point Dr. Günther remarks, "Wherever *Dipterus* and *Ceratodus* are placed, thither *Cheirodus* (M'Coy, Pander) or *Conchodus* (M'Coy) must follow. But it is probable that this genus is more nearly allied to *Ceratodus*"*.

Recently, through the kindness of Prof. Hughes of Cambridge, I have been able to examine M'Coy's original specimen of *Cheirodus pes-ranæ* preserved in the Woodwardian Museum; and, to my surprise, I found it to be nothing more or less than a mandibular dental plate, not of a Selachian, nor of a Dipnoan, but of the Platysomid fish named by Prof. Young, in 1866, *Amphicentrum*. The conformation of the bone and of its ridges is identical with what we find in the splenial element of Prof. Young's fish, as will be seen on comparing M'Coy's figure with that given by myself of the upper aspect of the splenial of *Amphicentrum granulosum* (Ann. & Mag. Nat. Hist. (4) xvi. 1875, pl. ix. fig. 8), though before I had seen the original of *Cheirodus* I should have hesitated in affirming their identity. There can, however, be no doubt that they belong to the same genus; the species is another question. In M'Coy's specimen it will be observed that the tubercles are quite obsolete; but as regards the number and prominence of these, great differences are found in different specimens of *Amphicentrum granulosum*, in some of which they are very slightly marked. Nevertheless I am, upon the whole, inclined to consider the species as distinct†

Cheirodus, M'Coy, is therefore not = *Cheirodus*, Pander, though the latter is possibly the same as M'Coy's *Conchodus*, which is undoubtedly a Dipnoous genus. As to the name *Chirodus* or *Cheirodus*, I should have preferred to have dropped it altogether, as it was founded on a mere fragment whose nature its describer did not understand; nor should we have understood it to this day but for the discovery of that

* *Op. cit.* p. 557.

† Mr. W. J. Barkas has recorded the occurrence of *Amphicentrum granulosum*, Young, in the Carboniferous Limestone of Richmond, Yorkshire, Geol. Mag. (2) i. 1874, p. 431.

Coal-measure fish of which Prof. Young gave the first description, and which is now so widely known under the name which he applied to it. But as the law of priority is nowa-days considered to be inexorable, I must, though much to my regret, propose the abolition of "*Amphicentrum*," retaining, however, "*pes-ranæ*," M'Coy, and "*granulosum*," Young, as distinct species of the genus *Cheirodus.*

EXPLANATION OF PLATE III.

Fig. 1. Palatal aspect of a skull of *Dipterus* from Thurso, in the Hugh-Miller collection. *n*, anterior nasal notch; *n'*, posterior nasal notch; *pt*, palato-pterygoid; *pa.sph*, parasphenoid; *qu*, quadrate; *x*, facet for mandibular articulation; *n.ch*, notochordal opening; *f. m*, foramen magnum; *b*, one of the marginal plates of the external cranial buckler, seen from its inner surface.

Fig. 2. Mandible of *Dipterus*, seen from above, a large amount of the matrix being left between the rami. Hugh-Miller collection. *d*, dentary; *ag*, angular; *ar*, articular; *sp*, splenial, with its dental plate.

Fig. 3. The same specimen, seen from below. *y, y*, lateral labial fossæ; the other letters as in fig. 2.

Fig. 4. The same specimen, seen from the right side. Lettering as in the preceding figures.

Fig. 5. *Palædaphus insignis*, Van Ben. & De Kon., seen from *above*; one fourth natural size, and taken from a plaster cast. Lettering as in the figures of *Dipterus.*

Fig. 6. The same, seen from below.

Fig. 7. The same, seen from the left side. Compare this figure especially with the similar view of the mandible of *Dipterus*, fig. 4.

II.—*Preliminary Notices of Deep-Sea Fishes collected during the Voyage of H.M.S. 'Challenger.'* By Dr. Albert Günther, F.R.S., Keeper of the Zoological Department, British Museum.

As some time must elapse before the second part of the Ichthyology of H.M.S. 'Challenger' (which will contain an account of the deep-sea and pelagic forms) can be published, it is proposed, with the sanction of the Lords Commissioners of H.M. Treasury, to publish preliminary diagnoses of the genera and species which are new to science. The materials collected have proved to be far more extensive than was at first anticipated; and the author has great pleasure on this occasion to express his gratification at the admirable manner in which the specimens have been preserved by the gentlemen intrusted with their care, and at the clear and simple method in which all necessary particulars connected with their capture have been noted.

Scyllium canescens.

The nasal valves are separate from each other, the distance between them being less than the length of a nasal opening; each is provided with a cirrus. Length of the præoral portion of the snout much less than its width or than the width of the mouth. Labial fold very short. The posterior dorsal slightly longer than the anterior. The anal terminates below the middle of the second dorsal, its base being longer than that of the latter fin and equal to its distance from the caudal. Uniform greyish; all the fins, except the caudal, tipped with white behind.

South-west coast of South America (Station 310), 400 fathoms.

BATHYDRACO, g. n. Trachin.

Body elongate, subcylindrical; tail tapering; head depressed, with the snout much elongate, spatulate; mouth wide, horizontal, with the lower jaw prominent; eyes very large, lateral, close together. Scales very small, imbedded in the skin. Lateral line wide, continuous. One dorsal fin; ventrals jugular; the lower pectoral rays branched. Teeth in the jaws in villiform bands; none on the vomer or the palatine bones. Opercles unarmed; ten branchiostegals; the gill-membranes free from the isthmus and but slightly united in front. Air-bladder none.

Bathydraco antarcticus.

D. 36. A. 31. P. 23. V. 1/6.

South of Heard Island (Station 152), 1260 fathoms.

Haloporphyrus rostratus.

B. 7. D. 4 | 51–56. A. 38–39. V. 6.

This species is readily distinguished by the peculiarly produced snout, which forms a short, triangular, pointed lamina, sharply keeled on the sides, and overreaching the cleft of the mouth.

Deep sea, midway between the Cape of Good Hope and Kerguelen's Land; east of the mouth of Rio Plata. (Stations 146 and 320.) 600 and 1375 fathoms.

This fish differs in some important points from *Haloporphyrus*, as the form of the snout, backward position of the vent, imperfect division of the anal, in which latter respect it approaches *Mora*; therefore it may be regarded as the type of a distinct subgenus *Antimora*.

Haloporphyrus australis.

D. 9 | 50–52. A. 53. V. 8.

This species is in general appearance similar to *Haloporphyrus lepidion*, but has a shorter and stouter body. The length of the head is one fourth of the total without caudal, the depth of the body two fifths.

Puerto Bueno, Magellan Straits, 55–70 fathoms.

MELANONUS, g. n. Gadid.

Head and body rather compressed, covered with cycloid scales of moderate size, and terminating in a long tapering tail, without caudal. Eye of moderate size; mouth anterior and lateral; both jaws with narrow bands of villiform teeth; vomer and palatines with very narrow stripes of minute teeth. Barbel none. One short anterior dorsal; the second commences immediately behind the first, and has the anterior rays well developed; it is continued to the end of the tail. Anal like the second dorsal. The outer gill-rakers of the first branchial arch strong and long, longer than the gill-laminæ. Ventrals composed of several rays, slightly in advance of the pectorals. Bones flexible; mucous cavities of the head small.

Allied to *Strinsia*, but with different dentition.

Melanonus gracilis.

Entirely deep black.

Antarctic (Station 156), 1975 fathoms.

Lotella marginata.

D. 7–8 | 65. A. 62. V. 5.

Head of moderate length, two ninths of the total, the caudal fin not included. Eye very large, more than one third of the length of the head, and equal to that of the postorbital portion; consequently the snout is short, though its length much exceeds the width of the interorbital space. The maxillary extends only to below the middle of the eye; jaws with an outer series of distinctly larger teeth. Barbel very small.

Pacific coast of South-western South America (Stations 305–308), 120 to 345 fathoms.

Sirembo Messieri.

Head oblong, deeper than broad, the snout being rather produced, rounded, overlapping the lower jaw. Eye of moderate size, one sixth of the length of the head, its diameter being two thirds of the length of the snout, and less than the width of the flat interorbital space. The maxillary extends behind the eye; præoperculum without spines. Scales minute, leaving the snout naked. Vertical fins rather low, the dorsal beginning above the extremity of the pectoral. The distance between the vent and root of the ventrals is much more than the length of the head; the ventrals are inserted behind the angle of the præoperculum, very close together, and do not extend so far backwards as the pectorals. Uniform brown, with black fins.

Off Middle Island, Messier Strait (Station 306), 345 fathoms.

Bathynectes, g. n. Ophidiid.

Anterior part of the body rather compressed, posterior produced into the long tapering tail, without caudal. Snout not swollen, with the jaws equal or nearly equal in front. Mouth very wide, with the teeth in villiform bands in the jaws, on the vomer and palatine bones. Barbel none. Ventrals reduced to simple or bifid filaments, placed close together and near to the humeral symphysis. Gill-membranes not united. The gill-laminæ are remarkably short; the middle pieces of the first branchial arch have the gill-rakers of the outer series much elongate, stiff. Bones of the head soft and cavernous. Operculum with a very feeble spine above.

A true deep-sea form allied to *Sirembo*.

Bathynectes laticeps.

Head slightly, body and tail more strongly compressed, low; the latter produced into a moderately long filament. Eye rather small, its diameter being one seventh of the length of the head, two thirds of that of snout, and two fifths of the interorbital space, which is convex. The posterior nostrils are wide; the muciferous channel of the infraorbital ring shows in its course five or six wide sinuses, and opens in front by a wide aperture. Mouth very wide, extending far behind the eye, with the extremity of the maxillary much dilated. Vomerine band of teeth **V**-shaped, with the two arms of the figure straight; palatine band narrow.

Mid-Atlantic (Station 104), 2500 fathoms.

Bathynectes compressus.

Head and the entire body and tail strongly compressed. Snout somewhat swollen. Eye very small, on the border between the first and second fourth of the length of the head. Nostrils open, openings oval. Mouth very wide, extending far behind the eye, with the bands of teeth externally visible. Vomerine band V-shaped, with the two arms of the figure curved; palatine bands long, nearly as wide as those of the intermaxillary. The distance of the vent from the root of the ventrals is about equal to the length of the head.

South-east of New Guinea; Mid-Atlantic, 1075–2500 fathoms.

Bathynectes gracilis.

Head and the entire body and tail compressed and low; the latter produced into a long filament. Eye of moderate size, its diameter being contained five and a half times in the length of the head, and once and a half in that of the snout and in the width of the interorbital space, which is somewhat convex. The posterior nostrils especially are wide; and the muciferous channel of the infraorbital ring shows in its course five or six wide sinuses. Mouth very wide, extending far behind the eye, with the extremity of the maxillary much dilated. Vomerine band of teeth V-shaped, with the two arms of the figure straight; palatine band narrow. The distance of the vent from the root of the ventrals is more than the length of the head.

South of New Guinea (Station 184), 1400 fathoms.

TYPHLONUS, g. n. Ophidiid.

Head large, compressed, with most of the bones in a cartilaginous condition; the superficial bones with large muciferous cavities not armed. Snout a thick protuberance, projecting beyond the mouth, which is rather small, inferior. Trunk very short, the vent being below the pectoral; tail thin, strongly compressed, tapering, without separate caudal. Eye externally not visible, reduced to a minute rudiment hidden below the skin. Bands of villiform teeth in the jaws, on the vomer and palatine bones. Barbel none. Ventrals reduced to simple filaments, placed close together on the humeral symphysis. Gill-openings very wide, the gill-membranes being but slightly united in front. Gills four; gill-laminæ rather short, gill-rakers of moderate length. Scales thin, deciduous, small.

Typhlonus nasus.

The head of this most remarkable form is somewhat compressed, deep, as thick in the rostral as in the opercular portion; its length is rather more than one fourth of the total. Protuberances formed by projecting portions of the cranium occupy the upper and lateral surfaces of the head; and, more especially, one in front and another on each side of the snout are very conspicuous.

North-east of Australia (Stations 181 and 198), 2440 and 2150 fathoms.

Aphyonus, g. n. Ophidiid.

Head, body, and tapering tail strongly compressed, enveloped in a thin, scaleless, loose skin. Vent far behind the pectoral. Snout swollen, projecting beyond the mouth, which is wide. No teeth in the upper jaw; small conical teeth in the lower, pluriserial in front and uniserial on the side. Vomer with a few rudimentary teeth; palatine teeth. Nostrils close together, small. No externally visible eye. Barbel none. Ventrals reduced to simple filaments, placed close together and near to the humeral symphysis. Gill-membranes not united. Four branchial arches, the posterior without gill-laminæ; the anterior with very short gill-rakers and with rather short gill-laminæ. Head covered with a system of wide muciferous channels and sinuses, the dermal bones being almost membranaceous, whilst the others are in a semicartilaginous condition. Notochord persistent, but with a superficial indication of the vertebral segments (as in some Leptocephaline forms).

Aphyonus gelatinosus.

The head, in the preserved specimen, is compressed, rather deep, and enveloped in loose skin; especially on the upperside of its anterior half the skin forms a large loose bag, which during life is probably filled and distended with mucus. Transparent, colourless, like a *Leptocephalus*.

Deep sea between North-eastern Australia and New Guinea (Station 184), 1400 fathoms.

Acanthonus, g. n. Ophidiid.

Head large and thick, armed in front and on the opercles with strong spines; trunk very short, the vent being below the pectoral; tail thin, strongly compressed, tapering, without caudal. Eye small. Mouth very wide, with the teeth in villiform bands in the jaws, on the vomer and palatine bones, and along the hyoid. Barbel none. Ventrals reduced to simple filaments, placed close together on the humeral symphysis. Gill-membranes not united. The gill-laminæ are remarkably short, the gill-rakers long, lanceolate, stiff. Scales extremely small. Bones of the head soft.

Acanthonus armatus.

The head of this remarkable fish appears of an extraordinary thickness compared with the thin and compressed trunk and tail; it is very broad across the frontal region, and not much longer than high, the small eye being much nearer to the end of the snout than to the gill-opening. The snout would be truncated in front; but its upper portion projects, terminating in two short acute spines. The large mouth is slightly oblique, the maxillary extending backwards beyond the middle of the length of the head. The jaws are equal in front. Two sharp edges run along each ramus of the mandible, to receive between them a wide muciferous channel.

North of New Guinea, 1075 fathoms.

BATHYGADUS.

Snout not projecting beyond the mouth. Mouth wide, anterior and lateral. Eye small or of moderate size. Teeth in both jaws villiform, in narrow bands, which occupy the whole length of the jaws. Barbels present or absent. The two dorsal fins are almost continuous; and the anterior rays of the second are not shortened, but gradually diminish in length in the narrow posterior portion of the tail. Anal rays feeble. Bones of the head cavernous, soft, without prominent ridges. Scales small, cycloid, deciduous.

Bathygadus cottoides.

The head is large, thick, and, in the nuchal region, of considerable depth.

Deep sea between New Zealand and Kermadec Island (Stations 169–171), 520–700 fathoms.

Macrurus longirostris.

Allied to *Macrurus trachyrhynchus.* The snout is produced into a long flattened process, pointed anteriorly, and not quite twice as long as the large eye. Scales of the body with smooth surface, but with from three to seven spinelets on the margin. They are rather irregularly arranged, there being four in a transverse series between the lateral line and dorsal fin. A series of projecting triangular spines along each side of the neck and the base of the anterior portion of the dorsal fin; a similar series along each side of the base of the anal extends much further backwards than the dorsal series, and, anteriorly, is lost on the side of the abdomen. These spines have smooth edges (not denticulated as in *M. trachyrhynchus*).

North-east of New Zealand (Station 169), 700 fathoms.

Macrurus holotrachys.

Snout not much produced, as long as the eye, which is large, its vertical diameter being considerably more than the width of the interorbital space. Anterior edge of the snout with three tubercles, one in the middle and one on each side. Each scale with a median series of spinelets, and with two or more isolated spinelets besides. Upper and lateral portions of the head covered with irregular rough scales, lower naked. There are five scales in a transverse series between the first dorsal spine and lateral line. Distance between the two dorsal fins scarcely equal to the length of the base of the first. Second dorsal spine with small barbs anteriorly; outer ventral ray produced into a filament. No scaleless fossa on the temple. Barbel very small. No bands or spots.

Deep sea, east of the mouth of the Rio Plata (Station 320), 600 fathoms.

Macrurus fasciatus.

Snout not much produced, shorter than the eye, which is very large, its vertical diameter being considerably more than the width of the interorbital space. Scales with from eight to ten subparallel keels. Upper and lateral portions of the head covered with small rough scales, lower naked. There are four scales in a transverse series between the first dorsal spine and lateral line; distance between the two dorsal fins equal to the length of the base of the first. Outer ventral ray produced into a filament. No scaleless fossa on the temple. Barbel small. Whitish, with broad irregular blackish bands across the back.

West-coast of the southern extremity of South America (Stations 305, 309, 311), 120–245 fathoms.

Coryphænoides rudis.

Snout obtusely conical, projecting beyond the mouth, which extends backwards to below the middle of the eye. The outer series contains stronger teeth in both jaws. Barbel about as long as the eye. *Scales* equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, and not arranged in series. There are eight scales in a transverse series between the first dorsal and the lateral line. Anterior margin of the second dorsal spine armed with barbs placed at some distance from each other. The second dorsal fin commences at a distance behind the first scarcely inferior to the length of the base of the first. The outer ventral ray produced into a long filament.

Pacific, north of Kermadec Island (Stations 170, 171), 500–650 fathoms.

Coryphænoides æqualis.

Snout conically projecting beyond the mouth, with rather obtuse upper edge; the cleft of the mouth extends nearly to below the centre of the eye. The teeth of the outer series are visibly stronger than the remainder. Barbel slender, but not so long as the eye. The interorbital space is flat, its width being considerably less than the diameter of the eye. The *scales* are equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, but arranged in from 8 to 12 series, the middle series not being more prominent than the others (as is the case in *Macrurus sclerorhynchus*). The entire margin of the scale is spinous. There are eight scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine somewhat produced, armed along its anterior edge with barbs pointing upwards and rather closely set. The second dorsal fin commences at a distance from the first which is less than the length of the head.

Deep-sea, south of Portugal, 600 fathoms.

Coryphænoides crassiceps.

Head very large, especially the anterior portion. Snout excessively broad and high, short, but longer than the eye, which is small. Mouth small, inferior, extending beyond the vertical from the centre of the eye. Teeth villiform, in narrow bands in both jaws. Barbel minute. Trunk of the body very short, the vent being immediately behind the vertical from the root of the pectoral. The *scales* are small, studded with very fine curved spinelets, which give the body the appearance of being covered with short villosities. A series of larger scales runs along each side of the base of the second dorsal fin. The second dorsal spine is very slender, obsoletely denticulated in front; the second dorsal fin commences at a very short distance behind the first.

North of Kermadec Island (Stations 170, 171), 520 and 650 fathoms.

Rem. This fish is closely allied to, and represents in the southern hemisphere, *C. norvegicus*.

Coryphænoides microlepis.

Snout short, obliquely truncated, slightly projecting beyond the mouth; eye exceeding in length that of the snout and the width of the interorbital space. Head much compressed, high. The cleft of the mouth does not quite extend to below the middle of the eye. Teeth of the outer series visibly stronger than the remainder. Barbel as long as the eye. *Scales* small, cycloid. There are thirteen scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine armed in front with distant barbs; the distance between the two dorsal fins equals the length of the head without snout. Trunk very short.

Feejee Islands (Station 173), 215 fathoms.

Coryphænoides Murrayi.

Snout short, but longer than the eye, which is small, its width being much less than that of the interorbital space. Canthus rostralis obtuse, without median tubercle. The cleft of the mouth extends to below the middle of the eye. Teeth of the outer series much stronger than the remainder. Barbel longer than the eye. *Scales* with five to seven crenulate radiating keels, some of which project beyond the rounded posterior margin of the scale. There are seven or eight scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine slightly prolonged, armed with distant barbs pointing upwards. The second dorsal fin commences at a considerable distance from the first, which, however, is rather less than the length of the head.

Deep sea, east of New Zealand (Station 168), 1100 fathoms.

Coryphænoides serrulatus.

The projecting part of the snout is short, with an obtuse upper edge, and with a rough tubercle in the middle. The cleft of the mouth extends to below the middle of the eye, which is comparatively large. The teeth of the outer series are visibly stronger than the remainder. Barbel about as long as the eye. The interorbital space is flat, its width rather less than the vertical diameter of the eye. The *scales* are equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, closely adpressed to the scale, and not arranged in series. There are seven scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine finely and closely serrate in front. The second dorsal fin commences at a considerable distance from the first, the distance being equal to the length of the head.

North-east of New Zealand (Station 169), 700 fathoms.

Coryphænoides filicauda.

Snout considerably projecting beyond the mouth, pointed in the middle; it is twice as long as the eye, which is unusually small, only half as wide as the interorbital space. Mouth rather wide, extending beyond the centre of the eye. Teeth villiform, in very narrow bands. Barbel minute. Præoperculum with the angle produced backwards, broadly rounded and crenulate on the margin. The terminal portion of the tail is prolonged into a long filament, more slender than in any of the other species. *Scales* thin, *cycloid*, and deciduous, six or seven in a transverse series between the first dorsal spine and the lateral line. The second dorsal spine slender, with the barbs in front very inconspicuous and sometimes entirely absent. The distance between the two dorsal fins is less than the length of the head.

Deep sea on both sides of the South-American continent; Antarctic Ocean. (Stations 157, 299, 325.) 1800–2650 fathoms.

Coryphænoides variabilis.

Snout obtusely conical, projecting beyond the mouth, the cleft of which extends behind the middle of the eye. The teeth of the outer series are visibly stronger than the remainder. Barbel nearly as long as the eye. The interorbital space is flat, its width being much more than the diameter of the eye, which is comparatively small. The *scales* are provided with five ridges, each ridge composed of several spines, and the central ridge being the strongest. There are eight scales in a transverse series between the first dorsal and the lateral line. Lower limb of the præoperculum scaleless. Second dorsal spine armed with barbs in front, which are rather distantly set. The second dorsal fin commences at a distance from the first which is less than the length of the head.

Midway between Cape of Good Hope and Kerguelen's Land; South of Australia; Mid-Pacific; south-west of Juan Fernandez. (Stations 146, 157, 246, 271, 300.) 135–2425 fathoms.

Coryphænoides affinis.

Snout obtusely conical, projecting beyond the mouth, the cleft of which extends behind the middle of the eye. The teeth of the outer series are visibly stronger than the remainder. Barbel shorter than the eye. The interorbital space is flat, its width being equal to the diameter of the eye, which is comparatively large. The *scales* are provided with five ridges, each ridge composed of several small spines, and the central ridge being the strongest. There are eight scales in a transverse series between the first dorsal and the lateral line. Præoperculum with the posterior margin slightly excised above the angle, and with the lower margin crenulate; both limbs of the præoperculum scaly. The second dorsal spine is armed with barbs which are rather closely set. The second dorsal fin commences at a distance from the first which is not much more than one half of the length of the head.

Deep sea, east of the mouth of the Rio Plata (Station 323), 1900 fathoms.

Coryphænoides carinatus.

Snout obtusely conical, projecting beyond the mouth, the cleft of which reaches nearly to below the middle of the eye. Teeth in the upper jaw "en cardes," those in the lower in a single series. Barbel well developed, but much shorter than the eye. Interorbital space flat, much narrower than the large eye, the diameter of which equals the length of the snout. The *scales* are provided with a very strong median keel, terminating in a projecting spine, and with several short and low ridges, which converge towards the median keel or run nearly parallel to it. There are six scales in a transverse series between the first dorsal and the lateral line. Præoperculum with hind margin undulated and with limbs scaly. The second dorsal spine is armed with rather small and somewhat closely set barbs. The distance between the two dorsal fins equals the length of the base of the first.

Deep sea near Prince Edward's Island (Station 145), 500 fathoms.

[To be continued.]

III.—Stromatopora *as distinguished from* Millepora. By Dr. Dawson, F.R.S. &c.

The April number of the 'Annals' reached me not long after the completion of a series of careful microscopic studies of the *Stromatoporæ* and allied forms, which abound in all our American formations from the Black-River Limestone to the Corniferous Limestone inclusive, and in which I had endeavoured to eliminate the misleading appearances due to peculiar states of preservation, association with foreign organisms, &c., and had arrived at the conclusion, stated in a memoir now in the hands of the Secretary of the Geological Society, that these fossils appertain to the group of Rhizopods. In these circumstances my attention was naturally attracted by the association of things known to me as very distinct in the heading of Mr. Carter's paper, "Identity in Structure of *Millepora alcicornis* and *Stromatopora*." After reading the paper I betook myself to the reexamination of the specimens of *Millepora* in our collections, but, I must confess, with the result of failing to find any indications whatever of the affinities so confidently asserted by Mr. Carter.

The typical *Stromatoporæ*, as Hall, Nicholson, and Winchell have shown, and as any one can see for himself in the well-preserved specimens from our Corniferous Limestone, are composed of thin concentric laminæ, perforated with minute pores, and connected with hollow and solid pillars. The allied forms known as *Caunopora* and *Cœnostroma* have in addition a secondary deposit between the laminæ, through which pass branching horizontal tubes or canals radiating from vertical tubes or bundles of tubes traversing the laminæ, and corresponding to the hollow pillars of the ordinary *Stromatoporæ*. These structures are detailed and figured in the paper already referred to.

The corallum of *Millepora*, on the contrary, has no concentric laminæ, though it sometimes presents accidental layers occasioned by interruptions of growth. Its structure is cancellate or reticulate, consisting of minute calcareous rods, completely confluent, and leaving irregular and vermicular interstices, only occasionally presenting the appearance of horizontal canals. It is penetrated with cells of two sizes, which are divided into compartments by distinct tabulæ. The structure is that of a tabulate coral with its cells imbedded in a copious reticulate cœnenchyma.

Though Mr. Carter appears to maintain that the horizontal passages sometimes seen in *Millepora* are homologous with the canal-system of Stromatoporidæ, in one place he says, "We have every thing structural in the corallum of *Millepora alcicornis* that is to be found in *Stromatopora*, *excepting* the *stelliform* systems of venation." Perhaps this apparent inconsistency arises from his not being aware of the fact that the stelliform or radiating canals do not occur in the common species of *Stromatopora*, but only in *Cœnostroma* and *Caunopora*, and that in these they are not superficial, except in broken or eroded specimens, but belong to the secondary or supplemental deposit. His opportunities of study, whether of *Millepora* or of *Stromatopora*, would seem, from his own statements, to have been somewhat limited. This may possibly account for the somewhat extraordinary identification of two classes of organisms which scarcely resemble each other in any thing except in being calcareous and porous. This excuse can, however, scarcely be offered for the statement in the concluding paragraph of the paper, that the "arborescent" forms in certain moss-agates are "as much like organic remains as the so-called *Eozoon* is remote from such resemblance,"—a statement difficult to understand, whether we consider the essential dissimilarity of *Eozoon* to any moss-agates, or the fact that, while most moss-agates show merely dendritic crystallizations, others contain true vegetable organisms.

As I have in my possession at present a considerable number of duplicate specimens of *Stromatopora*, in such a state of preservation as to show under the microscope their actual structure, I shall be happy to send by mail chippings of these specimens to any naturalists desirous of studying them and of comparing them with such organisms as *Loftusia* on the one hand or *Eozoon* on the other, with both of which the *Stromatoporæ* have decided affinities. I am sorry that I have not material at command to supply specimens of the genera *Cœnostroma*, *Caunopora*, *Syringostroma*, or *Dictyostroma* in such states of preservation as to show their structures advantageously.

Montreal, May 15, 1878.

IV.—*Notes on Carboniferous Mollusca.* By R. Etheridge, Jun., F.G.S.

[Plate I.]

1. *On the Hinge-structure and Generic Affinity of* Pecten Sowerbii, *M'Coy.*

When last I had occasion to refer* to this common and characteristic Carboniferous shell, I called attention, amongst other things, to the late Mr. Meek's remarks on its probable identity with *Pecten aviculatus*, Swallow. The peculiar hinge-structure of the latter, combined with that of *P. demissus*, Phill., of the European Oolitic rocks, afforded Mr. Meek the data for the diagnosis of his genus *Entolium*. With the exception of the central cartilage-pit †, the hinge-structure of our

* Geol. Mag. dec. 2, iv. p. 241. † Ibid. dec. 2, i. p. 302.

P. Sowerbii was previously unknown to me, although, from the great resemblance between the foregoing species, I felt convinced that time only was necessary to prove, at least to some extent, Mr. Meek's supposition. By the fortunate discovery of some well-preserved casts of *P. Sowerbii*, by Mr. J. Bennie, at Teasses Quarry, Fife, I am now able to demonstrate the fact that the latter is a species of Meek's genus *Entolium*, and that there is very little if any difference between *E. aviculatum*, Swallow, and *E.* (*Pecten*) *Sowerbii*, M'Coy.

For comparison I have given figures representing the hinge of the Oolitic form, *E. demissum*, Phill., and the Carboniferous *E. aviculatum*, Sw., after Quenstedt * and Meek † respectively.

If we first examine the cast of the valve of *E. Sowerbii* (fig. 4) with ears, we observe a small projection at *a*, which is the mould of the cartilage-pit, and corresponds with a similar pit in *E. demissum* (fig. 1) and *E. aviculatum* (fig. 2). Extending from this are two transverse ridges, one on each side (*b*, *b*), which are the moulds of the transverse furrows seen in the other species (figs. 1, 2). Extending obliquely from the cartilage-pit are two deep furrows (*c*, *c*), the moulds of two large diverging teeth strongly marked in relief in the interior of *E. demissum* (*c*, *c*, fig. 1) and *E. aviculatum* (*c*, *c*, fig. 2). From the distal extremities of these extend two longer but shallower furrows (*d*, *d*), also represented in the other specimens as ridges (*d*, *d*, figs. 1, 2). It is to be remarked that in by far the larger number of specimens of *E. Sowerbii* collected from our Carboniferous rocks the ridges (*d*, *d*) are visible externally, and have been referred to in descriptions of this species by Prof. M'Coy and myself. The posterior is usually the longer of the two.

In the opposite valve, that with the flat or normal ears (fig. 5), we see no trace of the transverse furrows (*b*, *b*), but still the oblique ones (*c*, *c*), identical with ridges in the corresponding valve of *E. aviculatum* (*c*, *c*, fig. 3); there are also present the extended ridges (*d*, *d*, fig. 5).

Of the diverging ridges (*c*, *c*) Mr. Meek remarked, " these, however, do not seem to have been properly teeth, fitting into sockets, but appear to have been a little raised in both valves, and occupy a position between the ears and the broad diverging impressions (*d*, *d*), descending obliquely from the beaks." The transverse grooves (*b*, *b* in figs. 1, 2, and 4) were regarded by Mr. Meek as a receptacle for the articulation of the straight cardinal margin of the opposite valve (figs, 3, 5).

* Der Jura, Atlas, t. 48. f. 6.

† Hayden's Final Report on Nebraska, t. 9. f. 11, *f*, *g*.

I have on previous occasions fully described *E. Sowerbii*; and it now only remains for me to refer to its relation with *E. aviculatum*. The close resemblance of the species was recognized and commented on by Mr. Meek himself; and the only points which he was able to use as distinctive characters were, the stronger concentric markings, absence of obscure minute radiating striæ, and the more pointed and elevated ears of *E. Sowerbii*. The strength of the concentric laminæ is a character which entirely depends upon the state of preservation of the specimen examined; in some individuals the lines are strong and well marked, in others scarcely perceptible. I have already shown * that *E. Sowerbii* does possess "obscure radiating striæ," which were particularly well shown in a specimen lent me by Mr. A. Patton. With regard to the acuteness and elevation of the ears, as little reliance can be placed on this as on the concentric striæ; for their general appearance does, to some extent, depend upon the position in which the shell was deposited previous to fossilization. I think there can be no better proof of their probable, if not absolute, identity than the fact, that so close and accurate an observer as Mr. Meek was unable to point out any more stable points of difference than the above. In conclusion, it may be stated, therefore, that in both forms the shell was thin and probably fragile, ornamented with concentric striæ of greater or less degree of strength, supplemented by fine radiating lines, and, under certain conditions, exhibiting the characteristic V-shaped markings or grooves over the whole shell; and, lastly, the hinge-structure is identical. It is always the wiser course, in dealing with specimens one has not personally examined, to speak with caution and a certain amount of reserve; but I am under the impression that *E. aviculatum*, Swallow, can at the best be only retained as a variety of *E. Sowerbii*, M'Coy.

The following species have the outward appearance of the genus *Entolium* (and it will be well for those possessing specimens, or access to such, to endeavour to elucidate the hinge and general internal structure of the shells), viz.:—

1. *Pecten discites* (Schl.), Goldfuss, Pet. Germ. ii. t. 98. f. 10, *d*.
2. *P. cingulatus* (Phill.), id. ibid. t. 99. f. 3, *b*.
3. *P. laminosus* (Mantell), id. ibid. t. 99. f. 9.
4. *P. striolatus*, Goldfuss, Pet. Germ. ii. t. 160. f. 7.
5. *P. Phillipsii*, id. ibid. t. 160. f. 6.

P. cristatus, Bronn, as figured by Goldfuss (*loc. cit.* t. 99.

* Geol. Mag. dec. 2, iv. p. 242.

f. 13, *b*, *d*), appears to possess the hinge-structure of *Entolium*, with the radiating internal costæ of *Amussium*.

2. *On the Hinge-structure of* Nucula gibbosa, *Flem.*, *and* Nuculana attenuata, *Flem.*

These shells were placed by the late Mr. J. W. Salter in his genus *Ctenodonta**, in which he has been followed by several other palæontologists, including, at one time, myself. A further examination of the subject, however, convinced me that this step had probably been taken by Mr. Salter without due consideration. *Ctenodonta* appears to be synonymous with *Tellinomya*, Hall, the latter having precedence in date, although Salter's definition of his genus was perhaps more comprehensive than that of Hall as originally given. *Tellinomya* is an undoubtedly good genus, and will, I anticipate, be found to have attained its greatest development in the Silurian rocks, although I have no doubt it extends into the Carboniferous.

The essential character of *Tellinomya* (or *Ctenodonta*), as distinguishing it from *Nucula* or *Nuculana*, is the entire absence of an internal cartilage-pit and the substitution for it of an external ligament; whereas in the two latter genera the cartilage is deposited in a well-marked pit beneath the umbones, and between the two ranges of teeth, anterior and posterior, in both valves, and there is no external ligament. One or other of these essential characters must therefore be shown to exist in the above species before their respective affinity or want of affinity with *Tellinomya* (= *Ctenodonta*) can be shown. Prof. M'Coy, many years ago, noticed the presence of a cartilage-pit in *Nucula gibbosa*, Flem.† He says, "I have clearly ascertained the presence of the angulated line of hinge-teeth and the intermediate cartilage-pit of *Nucula*." I have personally seen one or two good and clean interiors of this shell, and am quite able to corroborate Prof. M'Coy's statement of the existence of a cartilage-pit in *N. gibbosa*, and, in consequence, the reference of the species to the genus *Nucula*, made by Fleming, M'Coy, and other palæontologists. In *N. gibbosa* the hinge-line is curved, the anterior range of teeth being a little less than half the length of the posterior. In the best-preserved specimen I have seen (a left valve, figs. 8 & 9) there are twenty teeth on the posterior side of the cartilage-pit, and five or six on the anterior, in both cases the denticles enlarging as the cartilage-pit is receded from. In form the denticles are roughly triangular and projecting, with

* Iron Ores Gt. Brit. pt. 3, p. 221.
† Brit. Pal. Foss. p. 512.

the apices of the angles in each range, anterior and posterior, turned towards the cartilage-pit or umbo. The cartilage-pit is pyriform and oblique, its smaller or pointed extremity being placed immediately under the apex of the umbo, then expanding somewhat outwards and downwards into the cavity of the valve.

Dr. F. Roemer has given a figure of the interior of *N. gibbosa*, in the lately issued plates* of his 'Lethæa Geognostica;' but I do not observe any trace of a cartilage-pit there represented. The specimen must have been faulty or of another species.

With regard to *Nuculana* (*Leda*) *attenuata*, Flem., the case is somewhat different; for, so far as I am aware, the hinge-structure of this species has never been minutely described, although it may have been referred to in general terms by several authors. The hinge (figs. 6 & 7) is similar to that of *N. gibbosa*, with its anterior and posterior teeth well developed. The teeth and sockets increase in size outwards from the cartilage-pit, which occupies the apex of the arch. The number of the teeth is considerable in *N. attenuata*: in one specimen I have counted twenty-three on the longer side of the shell; and even then the series was incomplete. In the left valve the teeth are produced inwards (*i. e.* towards the beak) and outwards (*i. e.* into the cavity of the shell) into projecting denticles; so that the interlocking of the two series must have been very complete and secure. I wish more particularly, however, to draw attention to the cartilage-pit (*a*, figs. 6 & 7), which is triangular with a rounded base, and inclined, in most specimens I have examined, a little obliquely towards the shorter side of the shell. Prof. M'Coy notices the teeth of this shell in his description of it; but he appears to have been unable to satisfy himself as to the presence of a cartilage-pit†.

Collector—Mr. J. Bennie.

EXPLANATION OF PLATE I.

Fig. 1. *Entolium demissum*, Phillips, showing hinge-structure, after Quenstedt (Der Jura, Atlas, t. 48. f. 6).

Fig. 2. *Entolium aviculatum*, Swallow, valve with the elevated ears, after Meek (Hayden's Final Geol. Report on Nebraska, 1872, t. 9. f. 11, *f*).

Fig. 3. The same, opposite valve to fig. 2 (*loc. cit.* f. 11, *g*).

Fig. 4. *Entolium Sowerbii*, M'Coy, valve with elevated ears; natural size.

Fig. 5. The same, opposite valve to fig. 4. The same letters refer to cor-

* 1. Theil, 1876, t. 44. f. 13, *c*.

† Brit. Pal. Foss. p. 512.

responding parts in figs. 1–5: *a*, cartilage-pit; *b*, *b*, sockets for insertion of cardinal margin of opposite valve; *c*, *c*, "teeth," or dental ridges; *d*, *d*, oblique diverging impressions.

Fig. 6. *Nuculana attenuata*, Fleming, interior of part of left valve; natural size. Roscobie Quarry, near Dumfermline; shale above the Roscobie Limestone, Lower Carboniferous Limestone group.

Fig. 7. The same, enlarged twice.

Fig. 8. *Nucula gibbosa*, Fleming, interior of left valve; natural size. Roscobie Quarry, as before.

Fig. 9. The same, enlarged twice. The same letters refer to corresponding parts in figs. 6–9: *a*, cartilage-pit; *b*, posterior teeth; *c*, anterior teeth.

I am indebted for the above excellent drawings to my colleague, Mr. B. N. Peach.

V.—*On* Teichonia, *a new Family of Calcareous Sponges, with Descriptions of two Species.* By H. J. Carter, F.R.S. &c.

[Plate II.]

Usually the excretory canal-systems of the Calcispongiæ open into a common cavity, called by Dr. Bowerbank the "cloaca," which discharges itself at one or more apertures; hence such Calcispongiæ are tubular or sacciform respectively. But we should have a very imperfect idea of the Calcispongiæ if we assumed that this was invariably the case, as Haeckel appears to have done, and therefore has based his classification upon the sacciform character alone, as will be seen in the "General Observations" at the end of this communication; for there are some species which have no cloaca, but are muriform or foliate, and whose excretory canal-systems open directly upon the surface, of which the following descriptions may serve as illustrations.

Teichonellidæ (τεῖχος, a wall), new family.

Character. Vallate.

Teichonella, nov. gen.

Generic characters. Vallate or foliate, without cloaca. Vents numerous, confined to the margin or general on one side of the lamina only; naked.

1. *Teichonella prolifera*, n. sp. (Pl. II. figs. 1–5.)

Calcisponge. Foliaceous, vertical, plicate, proliferous. Colour yellowish white. Lamina thick; margin round or obtusely angular, convex or undulatory above (Pl. II. fig. 1, *a a a*), irregularly notched below, where the projecting parts may be expanded into pedal points of attachment (fig. 1, *e e*); surface uneven, interrupted here and there, on both sides, by a proliferous lamina, which originates from the upper margin, and may pass, after a short distance, insensibly into the surface of the parent lamina (fig. 1, *b b*), or grow into greater dimensions foliaceously or cactus-like (fig. 1, *c*). Pores invisible to the unassisted eye, scattered over the surface thickly and generally. Vents slightly marginated, naked (that is, without fringe round the mouth), arranged more or less in single line along the margin only (fig. 1, *d d d*, and fig. 2, *a a a*), variable in size, the largest about 1-48th inch in diameter and 1-8th inch apart. Internal structure minutely areolar, compact, traversed vertically by branched excretory canal-systems, which terminate respectively in the vents just mentioned (fig. 3, *a a*); largest canals, viz. those approaching the vents, about 1-32nd inch in diameter. Spicules of two forms, viz. triradriate and quadriradiate. Triradiate of two sizes, viz. small (fig. 4, *a*) and large (fig. 4), both equiangulate and equiradiate; rays straight, smooth, and sharp-pointed; the former, which is the staple spicule of the sponge, only one third of the size of the latter, which, although less numerous, is still plentifully distributed throughout the mass; ray of small triradiate about 1-200th inch, that of the large one 1-50th inch long. Quadriradiate also of two sizes, viz. small (fig. 4, *b*) and large (fig. 5); the former about the size of the small triradiate, and confined to the excretory canals, where its fourth arm (fig. 4, *c*), instead of being straight and equal in size like the rest, is curved and smaller, projects into the excretory canal, and is turned towards the vent. Large quadriradriate exceeding in size the large triradiate of the mass, confined to the surface, where three of its rays are horizontal (fig. 5, *a*), equiangulate and equiradiate, while the fourth or shaft (fig. 5, *b*) is much smaller and vertical; large rays smooth, sharp-pointed, and slightly curved inwards, applied to the surface of the sponge; fourth or small ray straight, smooth, and sharp-pointed, projecting into the interior; large quadriradiates most plentiful over the upper part of the lamina, where their centres are frequently not more than 1-180th inch apart, and, presenting a dark colour from the light passing into the fourth arm, may be easily mistaken for the pores, from which, however, they may be distinguished by being larger and more or less triangular, while the pores are smaller and round. Size of entire specimen (fig. 1) $3\frac{1}{8} \times 2\frac{1}{4} \times 1$ inches; length of margin of largest lamina (fig. 1, *a a a*), which is more or less plicate, about 6 inches; average thickness of lamina 1-6th inch.

Hab. Marine. Mode of growth (that, is whether pendent or erect) unknown.

Loc. Australia, Freemantle.

Obs. The specimen represented in figure 1 has been in the British Museum for many years, as indicated by the "register number," viz. "46. 8. 19. 101;" and other fragments of the same species, from Freemantle, in Australia, have been found among the late Dr. Bowerbank's collection of sponges, which has been purchased by the Trustees of the British Museum, one of which, chiefly to show the vents and excretory canal-systems respectively, is represented in figs. 2 and 3. It is by far the largest Calcisponge on record, and its spiculation so like that of *Leuconia Johnstonii*, Cart., = *Leucandra*, Haeckel, as, at first sight, to appear identical. The large quadriradiate whose horizontal rays are tessellated in among the surface-structure, while the fourth or vertical one projects into the interior of the sponge, undoubtedly adds greatly to the strength of the exterior. In its compressed vallate character, proliferous growth, and marginal apertures it is identical with many of the siliceous sponges, although the latter are, of course, much larger. The spicules vary in size below the measurements above mentioned.

2. *Teichonella labyrinthica*, n. sp. (Pl. II. figs. 6–9.)

Calcisponge. Subglobular, foliate, somewhat compressed; consisting of a short, thick, round stem (fig. 6, *d*), expanded into a mass of more or less vertical laminæ (fig. 6, *a a a*), which are so folded together, backwards and forwards, in and out, as to make it difficult to say whether the whole does not belong to one and the same lamina. Colour now greyish white. Surface of lamina even on both sides; margin thin, round, sinuous, following the plication, here and there everted. Pores invisible to the unassisted eye, confined to one side of the lamina (fig. 6, *b*). Vents uniformly spread over the other side, about 1-360th inch in diameter and 1-180th inch apart (fig. 6, *c*); the latter on the inner, and the former on the outer side respectively, where the lamina is folded upon itself and in contact (fig. 8). Internal structure minutely areolar, columnar (fig. 8, *d d d*), vertical to the sides of the lamina, which varies from 1-16th to 1-12th inch in thickness, thinning towards the margin. Columnar structure formed by aggregation of the straight arms of the triradiate spicules (fig. 10, *a*) into cylinders (fig. 9, *c*), which, traversing the areolar sarcode, pass directly from the pores on one (fig. 9, *a*) to the vents on the other side of the lamina (fig. 9, *b*), communicating on their way with the areolar cavities of the sarcode in which the spongozoa are situated. Spicules of two kinds, viz. triradiate and linear. Triradiates of one form only (fig. 10), consisting of one long straight ray (fig. 10, *a*), about 1-120th inch in length, terminated by two shorter curved ones nearly at right angles to it (fig. 10, *b*); the long ray bundled with its like, forming the wall of the cylinder, while the two others project in opposite directions into the cavities of the neighbouring cylinders respectively, which the wall separates, their points turned towards the vents (fig. 9, *c*). Linear spicules minute (fig. 11), consisting of a slightly undulated shaft, about 1-200th inch long, obtusely pointed at the inner, and spear-pointed at the outer end—that is, slightly inflated before the termination (fig. 11, *a*),—disposed in tufts so as to give a minutely villous surface to each side (fig. 9, *a*, *b*), indicated by a white line added to the columnar structure, which is thickest on the vent-side, where these spicules are twice the length of those on the pore-side (fig. 9, *b*). Size of entire specimen 2 inches long, $1\frac{4}{8}$ inch high, and $\frac{7}{8}$ inch thick.

Hab. Marine. Mode of growth (that is, whether pendent or erect) unknown.

Loc. Australia, Freemantle.

Obs. This specimen (figs. 6, 7) is in the collection to which I have alluded, and is second only in size to *Teichonella prolifera*, the foregoing species. In spiculation and in the structure of the lamina it is closely allied to *Grantia compressa*, Fleming, = *Sycandra*, Haeckel, also in the foliation, which here is like the convolute æstivation of a flower-bud (fig. 7). *Grantia compressa* itself often occurs in a foliated form, like the twisted leaves of a book.

General Observations.

It is impossible now to do any thing in the Calcispongiæ without reference to Haeckel's work on them, entitled 'Die Kalkschwämme' (1872, in 3 vols., one of which is the Atlas), so complete in every respect does this appear to be. Thus the whole of the Calcispongiæ are divided into three great families, viz. :—"1. Ascones: Grantien mit Lochcanälen; 2. Leucones: Grantien mit Astcanälen; and 3. Sycones: Grantien mit Strahlcanälen," illustrated respectively by diagrams in the Atlas (Tafn. 20, 40, and 60). Complete, however, as this appears to be, it is somewhat laughable that the self-constituted author of 'The History of Creation' should have omitted a whole family of these sponges, viz. that which I have just described; but such is the case, and therefore I have ventured, as a mere wanderer in this unknown field, at least to me, to make the addition. No one can deny that the illustrations of Haeckel's work are beautifully executed, and, although rendered more attractive by being magnified and accompanied by much diagram, still it would be difficult to place before the student any thing more impressive and useful. But when we come to detail, this is distorted to suit the theory: thus when we find the cilia of the "gastrula" or embryo, which are the paddles by which it progresses, reversed, and the new being made to go with its nether or obtuse end foremost in search of a place for fixation and further growth, it will be only necessary to watch the embryo under such circumstances, and its future development, to see that the author of 'The History of Creation' has been imaginative. But, unfortunately, this does not rest here; for then comes the difficulty of knowing how far this imagination may have extended (that is, how much may be true and how much due to fancy) in the 'Kalkschwämme:'

"Fronti nulla fides."

As yet I only know of two species of Calcispongiæ that belong to the family Teichonellidæ; and they are remarkable for their large size and peculiar mode of growth respectively. Hitherto only sac-like forms have been recorded; and these find analogous ones among the siliceous sponges; but now we have analogous ones also to the muriform, proliferous, and foliate siliceous sponges. It is not at all uncommon to find a siliceous sponge assuming first the form of a fan, then that of a clam-shell, with the vents on the concave surface, then curving round still more until the opposite sides meet and, lastly, uniting grow together so as to form a vase-shaped sponge, which, but for the mouth being expanded instead of contracted, would represent the sacciform shape of the calcareous sponges; while the structure being the same, *Teichonella labyrinthica* would, with a contracted mouth, under the same series of changes, become *Grantia compressa*. Probably time will add more species to the family of Teichonellidæ, each of which may possess a different form from those mentioned.

EXPLANATION OF PLATE II.

Fig. 1. *Teichonella prolifera*, n. sp., lateral view, natural size: *a a a*, largest lamina; *b b*, proliferous laminæ commencing; *c*, the same, of greater dimensions; *d d d*, vents and upper margin of laminæ; *e e*, pedal points of attachment.

Fig. 2. The same, upper view, natural size, to show, *a a a*, margin of lamina and vents.

Fig. 3. The same, and same specimen, lateral view of vertical section, natural size, to show :—*a a*, excretory canal-systems and vents; *b b*, pedal points of attachment rounded off by attrition. Diagram.

Fig. 4. The same, large triradiate spicule of general structure: *a*, small triradiate; *b*, small quadriradiate spicule; *c*, curved or fourth arm.

Fig. 5. The same, large quadriradiate spicule of surface: *a*, horizontal or curved arms; *b*, vertical arm or shaft.

Fig. 6. *Teichonella labyrinthica*, n. sp., lateral view, natural size: *a a a*, lamina; *b*, pore-side; *c*, vent-side; *d*, pedal point of attachment rounded off by attrition.

Fig. 7. The same, upper view, to show the interfoliation of the lamina.

Fig. 8. The same, to show:—*a*, pore-side; *b*, portion excised to show vents and internal structure of lamina; *c c*, vent-side; *d d*, vertical sections of lamina, to show cylindrical structure. Diagram.

Fig. 9. The same, portion of internal or cylindrical structure, much magnified, to show :—*a*, pore-margin; *b*, vent-margin; *c*, cylindrical canals with curved arms of triradiate spicules projecting into them.

Fig. 10. The same, triradiate spicule: *a*, long and straight arm forming, by aggregation, the walls of the cylinders respectively; *b b*, shorter curved arms projecting *into* the cylinders.

Fig. 11. The same, linear spicule, relatively magnified: *d*, the same, much more magnified, to show the form.

N.B.—The spicules of both species are relatively magnified and on the same scale.

VI.—*On the* Dascillidæ *of New Zealand.* By D. Sharp, Honorary Member of the New-Zealand Institute.

In this paper I have attempted to present a little knowledge about the species from New Zealand of one of the unattractive, and therefore comparatively little-known, families of Coleoptera. I have drawn up in a brief manner characteristics of twenty-eight species, all of them up to the present time unknown to naturalists; and I have, moreover, made a tolerably careful study of their structure, so as to offer what I hope will prove to be a successful introduction to their classification. I have arranged them in eight groups, or genera, for six of which I have coined new names, viz. *Byrrhodes*, *Cyprobius*, *Cyphanus*, *Veronatus*, *Mesocyphon*, and *Cyphotelus*; for the species of the two other groups I have used names already known to naturalists, viz. *Cyphon* for a dozen of obscure species which I cannot find to differ in their structure from numerous similar species inhabiting Europe and North America, and *Atopida*, which was applied by Adam White to the only species of the family which has, previous to this paper, been made known from New Zealand. As regards

White's species, *Atopida castanea*, I may remark that I have not described it in my paper, because all I know about it is, that the specimen of it existing in our national collection is distinct from any of the species I have myself been able to obtain for study; and that from its facies I judge it will prove to be sufficiently similar in its structure to the species I have called *Atopida* to allow its being classed with them in a first synthesis.

Out of these eight groups of New-Zealand species, five, viz. *Byrrhodes*, *Cyprobius*, *Cyphanus*, *Atopida*, and *Veronatus*, are connected together by a peculiarity in the srtucture of their head. This peculiarity is the existence of a deep fossa, extending downwards and inwards from the point of insertion of the antenna, and reaching as far as the extreme base of the stipe of the maxilla. This character has not yet been observed in any other than these New-Zealand species; and it naturally binds them together into a group, which may be placed between the *Dascilliens* and *Cyphoniens* of Mulsant *. *Cyphotelus*, another of the eight groups, is as yet only represented by a single species, which has not, I think, at present any near ally; it also may be classed between the *Dascilliens* and *Cyphoniens*; but it must not be joined in the same second synthesis with the *Atopida* allies. A seventh, *Mesocyphon*, may perhaps be classed actually with Mulsant's *Cyphoniens*; for though it does not quite agree with the characters he assigns to that group, it is so closely connected with the species of *Cyphon* which form the remaining New-Zealand group, that I do not think it can be disconnected from them except by an unnatural classification.

There can be little doubt that, when other localities of New Zealand are carefully examined, the number of species of the family occurring there will be doubled or trebled.

The species of Dascillidæ now known from all parts of the world are about 230 in number; and about fifty of these are from the European region, while another fifty are from the North-American province. Very little is known yet of Australian or Chilian species of the family; and it is therefore not worth while to attempt to reply at present to the interesting question, which suggests itself, as to what part of the world it is in which the nearest allies of these New-Zealand Dascillidæ are found. In fact all of a more general kind than the above considerations that can just now be said with advantage amounts to about this, that New Zealand is probably positively richer in these beetles than either the European or the

* Hist. Nat. des Coléoptères de France, "Brévicolles," 1865.

North-American region, and that on making a synthesis of the groups of species (genera), it is found that they form three distinct aggregates, one of which is varied and extensive and probably very characteristic of New Zealand—that the second of these aggregates consists as yet of but one species, in which the characters of the Dascillidæ are but poorly expressed, while the third and last of these secondary aggregates unites in a very complete and intimate manner with the European and North-American allies.

For the specimens that have enabled me to draw up this paper I am chiefly indebted to Captain Thomas Broun of Whangarei, and C. M. Wakefield, Esq., who was formerly resident at Christchurch, New Zealand. Prof. Hutton of Otago and Mr. T. Lawson of Auckland (through his brother Mr. R. Lawson, of Scarborough) have also contributed some additional species; and all of these gentlemen are here heartily thanked.

In order to facilitate the comprehension of the method I have followed in dealing with these insects, I add an introductory table (p. 43). This, though I hope it will be useful for a time, will probably be found unreliable in the case of a considerable number of fresh species being discovered, as I anticipate will be actually the case.

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1. *Byrrhodes gravidus*, n. sp.

B. magnus, latus, robustus, ovalis, sat convexus, dense subtiliter punctatus, dense conspicueque pubescens, fusco-castaneus; antennis elongatis, articulo basali crasso, secundo parvo, tertio elongato, quam quartus duplo breviore, quarto et sequentibus subæqualibus; prothorace valde transverso, elytris angustiore, margine anteriore profunde bisinuato, augulis anterioribus productis acutis, lateribus leviter rotundatis, angulis posterioribus obtuse rectis, basi subrotundata vix utrinque sinuata; elytris obsolete longitudinaliter costatis. Long. 10–12 m.m., lat. 6–7 m.m.

This large species recalls somewhat by its appearance some of the European *Byrrhi*, *B. scabripennis* for example. The very conspicuous pubescence on its elytra is rather irregularly arranged, so as to have a somewhat spotted appearance, and is very easily rubbed off.

I have received some very damaged specimens of this remarkable species from Captain Broun, who found them, I believe, at Auckland; and I have seen other individuals from the same source in the collections of Messrs. Pascoe and Wakefield.

Provisional Table of the Groups of New-Zealand Dascillidæ.

Species.			
1.	Size very large (½ inch long); antennæ elongate; prosternal process large. Group 1. *Byrrhodes*.	Prosternal process projecting through its whole length below the coxæ, and in front projecting a little further forwards than the middle piece of the prosternum, so as to make a prominent angle.	Antennæ inserted in a conspicuous fossa, *i.e.* the space extending towards the underside between the eye and the base of the mandible and maxillæ is deeply depressed.
2.	Size small (not ¼ inch long); antennæ not elongate; prosternal process small. Group 2. *Cyprobius*.		
3. 4. 5. 6.	Thorax not greatly narrower than the elytra, its sides explanate; head short and broad; labial palpi furcate; labrum largely exposed; prosternal process in front on a level with tips of front coxæ. Group 3. *Cyphanus*.	Prosternal process not more dependent than the tips of coxæ, and not forming a conspicuous or prominent angle in front at its junction with the middle piece of the prosternum.	
7. 8. 9.	Thorax much narrower than elytra, its sides not explanate; head exserted, and so appearing narrow; mandibles much exposed, owing to the diminution of the labrum; labial palpi not furcate. Group 4. *Atopida*.		
10. 11.	Thorax not greatly narrower than elytra, its sides not explanate; head moderately exserted; labrum much exposed; labial palpi not furcate; front coxæ projecting beyond the prosternal process, the front part of which is therefore immersed between them. Group 5. *Veronatus*.		
12. 13. 14. 15.	Apical joint of maxillary palpus longer than the preceding one. Group 6. *Mesocyphon*.	Mesosternum with a triangular impressed space in the middle in front to receive apex of prosternal process.	Antennal groove inconspicuous or absent.
16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27.	Apical joint of maxillary palpus shorter than the preceding one. Group 7. *Cyphon*.		
28.	Group 8. *Cyphotelus*.	Mesosternum without impression for reception of apex of prosternum.	

Group 1.—The only species yet brought to light to form this group exhibits the following characters:—

Size greater than other New-Zealand species; build robust. Antennæ elongate. Head short and broad, the interantennal portion not extended forwards; the antennal fossæ very profound, and making the angle of the gena at the base of the maxilla very prominent; genal line very acutely raised; mentum elongate, with the rather large bilobed ligula placed conspicuously at its apex; labial palpi not furcate, but with the 2nd joint much incrassate. Front coxæ elongate, oblique, transverse, excessively exposed; front band of prosternum excessively short; prosternal process entirely exposed below the coxæ, and forming in front a very prominent angle with the middle piece of the prosternum. Coxal articulation of meso- and metasterna perfect, and middle coxæ well imbedded.

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2. *Cyprobius nitidus*, n. sp.

C. ovalis, haud elongatus, sat convexus, parcius punctatus, nitidus, parcius longiusque pubescens, brunneo-castaneus; antennis minus elongatis, articulo tertio elongato, quam quartus haud duplo breviore; prothorace perbrevi, anterius in medio rotundato utrinque vix sinuato, angulis anterioribus haud productis, basi rotundata; elytris parcius punctatis. Long. 5 m. m., lat. $2\frac{7}{8}$ m. m.

This species has quite the form aud appearance of the species of *Cyphon*. The pubescence of the elytra is longer and less depressed than in any other New-Zealand species here described, but it is rubbed off under very slight friction.

Sent from Tairua by Captain Broun to Mr. Wakefield and myself as nos. 5 and 7.

Group 2.—A single species (no. 2) is also all I can at present assign to this group. It departs but little in its structural characters from *Byrrhodes*; it is, however, of rather small size, and the antennæ are only moderately long; the head is very short, and the parts of the mouth very little prominent; and the mentum is rather shorter than it is broad, differing therefore strikingly from that of *Byrrhodes gravidus*.

Both by structure and appearance this form connects the group of peculiar New-Zealand genera possessing a deep antennal fossa with the group no. 7 of this paper (*Cyphon*), in which the fossa is absent.

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3. *Cyphanus laticeps*, n. sp.

C. oblongus, sat latus, crebre punctatus, sat nitidus, subtiliter minus conspicue pubescens, rufo-castaneus ; antennis elongatis, articulo basali crasso, tertio elongato, quam quartus fere duplo breviore ; prothorace brevi, elytris tantum paullo angustiore, anterius in medio minus lobato, angulis anterioribus nullo modo prominulis, rotundatis, lateribus explanatis, sat curvatis, basi utrinque subsinuata, angulis posterioribus rotundatis, subtiliter punctato ; prosterni processu angusto, apice lineari, acuminato. Long. $6\frac{1}{2}$ m. m., lat. vix 3 m. m.

The subparallel form of this insect, and especially its short, broad head, give it a peculiar facies, which suggests a similarity to the European *Anobium molle*, quite as much as to the Dascillidæ.

This and the following species were sent from Tairua to Mr. Wakefield and myself, as no. 6, by Captain Broun.

4. *Cyphanus punctatus*, n. sp.

C. oblongus, sat latus, crebre punctatus, sat nitidus, subtiliter minus conspicue pubescens, rufo-castaneus ; antennis elongatis, articulo basali crasso, tertio elongato, quam quartus fere duplo breviore ; prothorace brevi, elytris tantum paulo angustiore, anterius in medio minus lobato, angulis anterioribus nullo modo prominulis rotundatis, lateribus explanatis, sat curvatis, basi utrinque subsinuata, angulis posterioribus rotundatis, subtiliter punctato ; elytris elongatis, crebre fortiterque punctatis ; prosterni processu lato, a medio ad apicem graduatim acuminato. Long. $8\frac{3}{4}$ m. m., lat. vix 4 m. m.

This species is excessively like the preceding one, but is twice the size, and shows a decided difference in the prosternal process. As Captain Broun did not distinguish the two, it is possible they may prove to be the sexes of one species.

I have seen but one individual of this species ; like the preceding one it was sent from Tairua by Captain Broun as no. 6.

5. *Cyphanus mollis*, n. sp.

C. suboblongus, sat latus, haud convexus, subtiliter punctatus et pubescens, ferrugineus, elytris testaceis ; capite lato, brevi, antennis elongatis, articulo basali crasso, tertio elongato, quam quartus haud dimidio breviore ; prothorace subtilissime punctato, nitido, brevi, lato sed elytris evidenter angustiore, anterius subtruncato, angulis anterioribus rotundatis nullo modo productis, lateribus explanatis, subrectis, angulis posterioribus subrotundatis, basi in medio evidenter lobata ; elytris dense subtiliter punctatis, fere opacis, longitudinaliter vix conspicue tricostatis. Long. 8 m. m., lat. $3\frac{5}{8}$ m. m.

Though rather similar to the preceding species, this is distinguished by numerous characters easily perceived: the eyes are more prominent; the thorax is narrower in proportion to the elytra; and the punctuation of the elytra is very much finer.

This species is another of Captain Broun's discoveries at Tairua; a single specimen each has been received by Mr. Wakefield and myself as no. 5.

6. *Cyphanus debilis*, n. sp.

C. suboblongus, haud latus, dense subtiliter punctatus et pubescens, subopacus, ferrugineus, elytris dilutioribus; antennis elongatis, articulo basali crasso, tertio elongato quam quartus dimidio breviore; capite sat angusto, mandibulis sat elongatis, porrectis; prothorace dense subtiliter granuloso-punctato, opaco, brevi, sat lato, angulis anterioribus rotundatis nullo modo prominulis, lateribus anguste explanatis, subrectis, angulis posterioribus omnino rotundatis, basi utrinque haud perspicue sinuata; elytris dense subtiliter punctatis. Long. 6 m. m., lat. $2\frac{2}{5}$ m. m.

This species in appearance is quite as much allied to the following as it is to the preceding ones; yet it is with these that its structural characters associate it. The specimens I have seen are in extremely bad condition.

This species has been sent from Tairua by Captain Broun as no. 8.

Group 3 is formed by species nos. 3, 4, 5, and 6, which possess the following characters:—

Form rather elongate and narrow, size moderate. Antennæ elongate. Head short and broad, the interantennal portion not extended forwards; the antennal fossæ very profound, and at their termination very distinctly separating the genæ from the extreme basal portion of the maxillæ; mandibles large, moderately prominent; labrum exposed, separated by a short membranous space from the front of the head; labial palpi strongly furcate; *i.e.* the 2nd joint is so formed that it appears to be the terminal one, the 3rd joint being inserted on the basal portion of its inner side. Front band of prosternum excessively reduced; prosternal process hastate in form, projecting much further backwards than the coxæ, its junction in front with the middle piece of the sternum is on a level with the tips of the coxæ. Coxal articulation between meso- and metasternum good.

N.B. This is the only group of New-Zealand species having the labial palpi furcate.

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7. *Atopida Lawsoni*, n. sp.

A. angustula, sat convexa, fusco-castanea, antennarum basi elytrisque dilutioribus, pedibus testaceis; capite exserto, dense granuloso-punctato, opaco; mandibulis porrectis; antennis elongatis, articulo tertio elongato, quarto longitudine æquali; thorace valde transverso, elytris angustiore, basin versus angustato, anterius subtruncato, angulis anterioribus acutis, basi elytris applicata, angulis posterioribus subrectis, dense granuloso-punctato, granulis ante basin minus confertis; elytris nitidis, fortiter sat crebre punctatis. Long. $5\frac{1}{2}$ m. m., lat. 2 m. m.

Though closely similar to the following species, this is evidently quite distinct; the thorax is broader, and the sculpture is less dense, the elytra are more coarsely punctured, and the pubescence of the upper surface is less. Structurally, however, this species is very distinct from the following ones, by the fact that its labrum is much more largely developed and is quite exposed, its lateral portions being elongate, while the middle is very short, so that the general shape of the labrum in front is a broad curve.

The only specimen at my disposal is one sent by Mr. Thomas Lawson from Auckland; I have named the species after him.

8. *Atopida Brouni*, n. sp.

A. angustula, sat convexa, castanea, capite thoraceque rufo-obscuris, pedibus testaceis; capite exserto, dense granuloso-punctato, opaco, mandibulis porrectis; antennis elongatis, articulo tertio elongato, quarto longitudine æquali; thorace transverso, elytris multo angustiore, basin versus angustato, anterius subtruncato, angulis anterioribus acute rectis, basi elytris applicata, angulis posterioribus subrectis, toto dense granuloso-puuctato, omnino opaco; elytris crebre fortiterque punctatis, breviter sparsim pubescentibus, sat nitidis; segmentis ventralibus parce punctatis. Long. 6 m. m., lat. $2\frac{1}{4}$ m. m.

I have named this species in honour of Captain Broun, to whom we are indebted for its discovery, as indeed for most of its allies. I recently received two individuals from Tairua as no. 8.

9. *Atopida proba*, n. sp.

A. angustula, sat convexa, rufescens, supra opaca, obscura, pedibus testaceis, dense punctata, conspicue pubescens; capite exserto, densissime punctato, opaco, mandibulis porrectis; antennis sat elongatis, articulo tertio elongato, quam quartus paulo breviore; thorace transverso, elytris multo angustiore, basin versus angustato, anterius truncato, angulis anterioribus depressis nullo modo acutis, basi elytris applicata, angulis posterioribus subrectis, densissime punctato, omnino opaco; elytris dense fortiterque punctatis, evidenter pubescentibus, haud nitidis; segmentis ventralibus dense punctatis. Long. 5 m. m., lat. 2 m. m.

This species is smaller than the preceding one, and is readily distinguished by the different punctuation and pubescence of the elytra, and by the indistinct front angles of the thorax; in its general form it approximates a good deal to the European *Anobium castaneum*, Fab.

Mr. Wakefield and myself have received the species from Captain Brcun as no. 4; I do not know whether it was found at Tairua or Auckland.

Group 4.—Species 7, 8, and 9 unite to form this group, characterized by the characters given below. I believe *Atopida castanea*, White, will also be referable to it.

Form narrow and elongate. Antennæ rather long. Head exserted, rather elongate, the interantennal portion not extended forwards; the antennal fossa profound, and at its termination separating the gena from the base of the maxilla. Mandibles large and exserted, their basal portion exposed, and the labrum and the membranous space separating it from front of head scarcely to be detected (except in *Atopida Lawsoni*). Labial palpi very small and not furcate. Maxillary palpi short. Front band of prosternum short, but not so excessively reduced as in the preceding groups; prosternal process elongate-hastate, projecting much behind the front coxæ, its junction in front with the middle piece of prosternum on a level with the tips of the coxæ.

The most striking feature of this group is the great exposure of the mandibles by the reduction of the labrum and membranous front of the head; in these respects, however, *Atopida Lawsoni*, although it has quite the appearance of the other two species, is intermediate between them and *Cyphanus debilis*, so that, in so far as that character goes, the *A. Lawsoni* might be considered to connect the two groups; but as the remarkable labial palpi of the *Cyphanus* group strongly differentiate it, *Atopida Lawsoni* is at present classed with the other species I have called *Atopida*.

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10. *Veronatus longicornis*, n. sp.

V. elongatus, ferrugineus, thorace elytrisque testaceis, illo medio, his sutura fuscis; capite minus exserto, sat lato, pone oculos dense subtilissime, anterius parce punctato; antennis elongatis, tenuibus, articulo tertio elongato quam quartus dimidio breviore; prothorace parce subtiliterque punctato, lato sed elytris evidenter angustiore, anterius utrinque sinuato, angulis anterioribus minus late rotundatis, lateribus haud explanatis, leviter curvatis, basi utrinque sinuata, angulis posterioribus obtusis, haud rotundatis; elytris crebre fortiter punctatis. Long. $7\frac{1}{2}$ m. m., lat. 3 m. m.

I have seen only two individuals of this insect. They are in very bad condition; but although they show scarcely any pubescence on the upper surface, I hardly think this is due to abrasion. They are both males; the middle of the hind margin of the penultimate and antepenultimate ventral segments has a fringe of long pubescence, which is continued forwards at each end onto the face of the segment, so as to form a kind of curved mark.

Sent from Tairua by Captain Broun, and labelled (I think) no. 2.

11. *Veronatus longipalpis*, n. sp.

V. elongatus, angustulus, dense punctatus, opacus, ferrugineus, prothorace basi in medio nigricante, elytris fusco-ferrugineis; capite exserto, sat lato, dense subtiliter punctato, opaco; antennis elongatis, tenuibus, articulo tertio elongato quam quartus vix duplo breviore; prothorace brevi, elytris paulo angustiore, dense subtiliterque punctato, conspicueque pubescente, anterius utrinque vix emarginato, angulis anterioribus haud productis, rotundatis, lateribus curvatis, basi subrotundata, utrinque vix sinuata, angulis posterioribus obtusis; elytris inæqualibus, evidenter tricostatis, maculatim pubescentibus, dense subtiliter punctatis, opacis. Long. 8 m. m., lat. vix 3 m. m.

This species is remarkable on account of the surface of the elytra, which are quite distinctly longitudinally tricostate, and also bear numerous large but very indefinite depressions, while the short, but conspicuous, yellow, silky pubescence is arranged in such a manner as to cause a spotted appearance.

This species is another discovery of Captain Broun's at Tairua; both Mr. Wakefield and myself have received it from him.

Group 5.—Formed by species nos. 10 and 11.

These two species have the structural characters assigned to Group 3 (*Cyphanus*), except as follows:—The form is still more elongate; the labial palpi are not in the least furcate; and the junction of the prosternal process with the middle piece of the prosternum is concealed between the tips of the front coxæ. The two species are rather discordant, and I do not think it is probable that ultimately they will be associated together in a first synthesis. *Veronatus longipalpis* seems to have one of the lobes of the maxillæ prolonged to form an elongate slender process; and the termination of the antennal fossa on the underside of the head does not separate the gena from the extreme base of the maxilla.

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12. *Mesocyphon marmoratus*, n. sp.

M. angustulus, ferrugineus, capite, thorace, pectore antennisque extrorsum plus minusve infuscatis, elytris nigro testaceoque variegatis, pedibus testaceis; antennis sat elongatis; capite angustulo, thorace paulo angustiore densissime punctato, omnino opaco, oculis prominulis; thorace parvo, elytris multo angustiore densissime punctato, peropaco, anterius subtruncato, angulis anterioribus deflexis, haud productis, lateribus vix curvatis, posterioribus leviter angustatis, basi rotundata, angulis posterioribus obtusis haud rotundatis; elytris crebre indistincte punctatis, sat nitidis. Long. $3\frac{1}{2}$ m. m., lat. $1\frac{1}{2}$ m. m.

The coloration of the elytra is so variable, that it is generally not quite similar on the two wing-cases of an individual; it is a kind of marbling, somewhat like what exists in the genus *Heterocerus*. I can see no certain sexual characters in the individuals before me.

I received half a dozen individuals from Captain Broun, found at Tairua, two or three years ago.

13. *Mesocyphon setiger*, n. sp.

M. angustulus, fusculus, abdomine, antennarum basi pedibusque testaceis, prothoracis marginibus elytrorumque summa basi ferrugineis; densissime subtilissimeque punctatus, opacus; elytris marmoratis, brevissime pubescentibus, et præterea setis minutissimis munitis; capite angustulo, quam thorax paulo angustiore, densissime punctato, omnino opaco, oculis prominulis; thorace elytris multo angustiore, antrorsum truncato, angulis anterioribus rotundatis, lateribus rectis, versus basin nullo modo angustatis, angulis posterioribus rotundato-obtusis. Long. $3\frac{1}{2}$ m. m., lat. $1\frac{2}{3}$ m. m.

At first sight this might be considered a dark variety of *Mesocyphon marmoratus*; but it is really very distinct: the thorax is rather different in form; the sculpture of the elytra is very fine and dense, so that they are quite dull, their pubescence is excessively short, but mixed with it are some fine setæ, and their marbled appearance seems to depend on a variegate pubescence as much as on the variegation of the wing-case itself.

Auckland. A single individual sent by Captain Broun amongst some duplicate Coleoptera.

14. *Mesocyphon Wakefieldi*, n. sp.

M. angustulus, minus elongatus, colore variabilis, ferrugineus, capite, thorace, pectore antennisque extrorsum plus minusve infuscatis, elytris nigro testaceoque variegatis; antennis fere brevibus; capite angustulo, thorace paulo angustiore, dense, indistincte punctato, opaco, oculis prominulis; thorace parvo, elytris multo angustiore, dense indistincte punctato, anterius subtruncato, angulis anterioribus valde deflexis, lateribus vix curvatis, posterius haud angustatis, basi rotundata, angulis posterioribus obtusis minus distinctis; elytris dense indistincte punctatis, vix nitidis, minus parallelis. Long. 3 m. m., lat. $1\frac{1}{2}$ m. m.

Though very similar to *Mesocyphon marmoratus*, this is undoubtedly distinct; besides being much smaller, it shows numerous little differences in form and sculpture.

I have named this species after C. M. Wakefield, Esq., who has found it at Christchurch and on the west coast of the South Island.

15. *Mesocyphon divergens*, n. sp.

M. subovalis, vix angustus, depressus, dense punctatus, opacus, colore variabilis, ferrugineus, thorace disco plus minusve infuscato, elytris posterius irregulariter nigro signatis; antennis elongatis, articulo tertio elongato, quam quartus paulo breviore; capite angusto, quam thorax duplo angustiore, dense subtilissimeque punctato, opaco, oculis convexis; thorace subtiliter punctato, elytris angustiore, basi quam apex latiore, anterius utrinque subsinuato, angulis anterioribus rotundato-obtusis, basi utrinque sinuata, angulis posterioribus subrectis; elytris amplis, dense indistincte punctatis, opacis; tibiarum calcari apicali conspicuo. Long. $5\frac{1}{2}$ m. m., lat. $2\frac{5}{8}$ m. m.

Though rather closely allied to the three preceding species in its structure, the present one is much larger, and departs much from them in form. It has the antennæ and legs more elongate; and the tibiæ are armed at the extremity with a rather long spur; the variegation of the elytra is less conspicuous, and seems generally reduced to some small irregular black marks on the hinder half; the colour, however, is variable, the upper surface being sometimes much infuscate.

This species has been found by Mr. Wakefield on the west coast and in the Otira pass.

Group 6.—Species 12 to 15 are associated together as follows :—

Form rather elongate and depressed. Head rather elongate, the interantennal portion distinctly prolonged forwards. Antennal fossa indistinct. Mandibles slender, greatly crossed in repose, and therefore projecting but little beyond the front of the much-exposed labrum. Maxillary palpi elongate, slender, the apical joint slender, and so not appearing acuminate, longer than the preceding joint. Labial palpi not furcate. Front band of prosternum short, but not excessively reduced, prosternal process small, hastate, pointed behind, its junction in front with the middle piece of the prosternum on a level with tips of the coxæ.

It is impossible to unite these insects in a first synthesis with Group 7 (*Cyphon*) unless intermediate forms are discovered; they differ from the *Cyphones* by the maxillary palpi, by the less-reduced front band of the prosternum, and by the acuminate prolongation of the prosternal process. *Mesocyphon divergens* in its appearance departs much from the other three species; but I have not discovered any important points to differentiate it from them. I suspect the species of this group will ultimately prove to be rather numerous.

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16. *Cyphon Huttoni*, n. sp.

C. sat angustus et convexus, fere elongatus, fere opacus, ferrugineus, pedibus testaceis, elytrorum lateribus in medio infuscatis; capite angustulo et haud brevi, partibus oris porrectis, densissime fortiter granulato, peropaco, conspicue pubescente; thorace densius granulato, et pubescente, elytris multo angustiore, lateribus subrectis, vix posterius latioribus, angulis anterioribus rectis, posterioribus obtusis, haud rotundatis; elytris circa scutellum granulatis et opacis, apice subtiliter punctatis et nitidis, post scutellum profunde oblique impressis. Long. $3\frac{1}{3}$ m. m., lat. $1\frac{1}{2}$ m. m.

This is a very distinct species from the following ones, and aproximates closely to *Mesocyphon marmoratus* and its allies. The only individual I have seen has lost half of its antennæ; joint 3rd is slender and moderately long, quite half as long as the rather slender and elongate 4th joint; the 5th and 6th joints are each a good deal shorter than the 4th.

This species was sent from Otago by Professor Hutton.

17. *Cyphon parviceps*, n. sp.

C. parvulus, sat latus, haud elongatus, dense minus subtiliter punctatus et pubescens, ferrugineus, sat nitidus; capite parvo, haud elongato, crebrius granulato; antennis brevibus, articulo tertio gracili, haud brevi, sed quam quartus conspicue breviore, articulis 6^o–10^m subæqualibus, haud vel vix longioribus quam latioribus; thorace crebrius granulato, basi utrinque vix sinuata, angulis posterioribus rectis; elytris crebrius sat fortiter punctatis, pone scutellum impressis. Long. $2\frac{1}{4}$ m. m., lat. $1\frac{1}{8}$ m. m.

The coarse punctuation and the entire absence of the subocular line readily distinguish this little species.

Several specimens have been sent from Auckland by Captain Broun.

18. *Cyphon pumilio*, n. sp.

C. parvulus, angustulus, elytris elongatis, subtiliter minus crebre punctatus, sat nitidus; capite parvo, haud elongato, subtilius punctulato, sat nitido; antennis haud elongatis, articulis duobus basalibus sat crassis, tertio gracili sat brevi multo minore quam quartus; thorace parvo, obsolete punctulato, sat nitido, basi utrinque vix sinuata; elytris crebre minus subtiliter punctatis, sat nitidis, pone scutellum haud impressis. Long. 2 m. m., lat. $\frac{3}{4}$ m. m.

This is another species that is very readily distinguished from any of the other New-Zealand ones before me by the absence of the subocular line and the fine punctuation of the head and thorax, and the unimpressed elytra. I have not alluded in the above diagnosis to its colour, as the two individuals before me are very discrepant in this respect. It is the most minute of all the species described in this paper.

Two individuals from Auckland are all I have seen of this species.

19. *Cyphon arduus*, n. sp.

C. parvulus, neque angustulus nec elongatus, subtiliter sat crebre punctatus, conspicue pubescens, sat nitidus; capite parvo, dense subtiliter punctato, fere opaco; antennis haud elongatis, articulo tertio gracili, quam quartus multo minore; prothorace subtiliter inconspicue punctato, basi quam elytrorum basis haud angustiore, utrinque versus angulos posteriores sinuata; elytris amplis, haud elongatis, crebre sat subtiliter punctatis, haud perspicue impressis. Long. $2\frac{1}{3}$ m. m., lat. $1\frac{1}{3}$ m. m.

This species is quite intermediate between *C. pumilio* and *C. oscillans*: its larger head and thorax and shorter and broader elytra distinguish it from the former; it has the head and thorax smaller than in the following species, and the punctuation closer, and the colour is darker.

I have seen only one specimen, which was sent from Auckland by Captain Broun.

20. *Cyphon oscillans*, n. sp.

C. neque angustulus nec elongatus, minus crebre, distincte punctatus, conspicue pubescens, nitidus, testaceus, corpore supra plerumque plus minusve fusco-picto; capite mediocri, obsolete punctato, subnitido; antennis minus gracilibus, haud elongatis, articulo tertio parvo, quam quartus fere plus duplo breviore; prothorace subtiliter inconspicue punctato, haud parvo, basi elytrorum humerûm latitudine, utrinque subsinuata; elytris minus crebre punctatis, nitidis, haud perspicue impressis. Long. $2\frac{1}{2}$ m. m., lat. vix $1\frac{1}{2}$ m. m.

This species is but little dissimilar in form and appearance to the European *C. padi*, but it is a good deal smaller. The dark marks on the upper surface are excessively variable; they exist either on head, thorax, or elytra, but are sometimes absent from one or all of these parts.

A few specimens have been sent from Tairua by Captain Broun, and were stated to be found on *Cyathea dealbata.*

21. *Cyphon æqualis*, n. sp.

C. major, sat latus, distincte parcius pubescens, nitidus, testaceus; capite lato, sat evidenter sed haud dense granulato; antennis elongatis, minus gracilibus, articulo tertio parvo, quam quartus triplo minore, articulis 4^{o}–11^{m} singulis longitudine quam latitudo duplo vel triple majore; prothorace majore, obsolete punctato, basi elytrorum humerûm latitudine, utrinque leviter sinuata; elytris crebre fortiter punctatis, nullo modo basin versus impressis. Long. $3\frac{7}{8}$ m. m., lat. vix 2 m. m.

This species will be readily enough distinguished by the comparatively large size, pale colour, unimpressed elytra, obsolete subocular line, and great disparity between 3rd and 4th antennal joints. The species is similar in its colour and general appearance to the European *C. variabilis*, but it is broader, and has the antennæ longer and thicker.

Mr. Wakefield has found this species near Christchurch.

22. *Cyphon graniger*, n. sp.

C. angustulus, sat elongatus, evidenter pubescens, sat nitidus, testaceus, elytrorum sutura plus minusve infuscata; capite haud lato, crebrius granulato, opaco; antennis elongatis, minus gracilibus, articulo tertio parvo, quam quartus triplo minore, articulis 4^{o}–11^{m} singulis longitudine quam latitudo duplo majore; prothorace majore, crebrius conspicue granulato, fere opaco, basi rotundata, utrinque vix sinuata; elytris crebrius minus fortiter punctatis, haud impressis. Long. 3 m. m., lat. $1\frac{1}{3}$ m. m.

This is another species which, *primo visu*, greatly resembles the European *C. variabilis*; it is readily distinguished from *C. æqualis* by its smaller size and narrower form and the distinct granulation of the thorax.

This is another of Mr. Wakefield's captures at Christchurch.

23. *Cyphon pictulus*, n. sp.

C. angustulus, sat elongatus, densius pubescens, fusco-ferrugineus, antennis, pedibus, thorace elytrisque testaceis, his nigro variegatis; capite angustulo, crebrius granulato, fere opaco; antennis haud elongatis, articulo tertio quam quartus duplo breviore; prothorace haud lato, subtiliter inconspicue granulato, basi elytrorum humerûm fere latitudine; elytris crebrius fortiterque punctatis, densius pubescentibus, versus basin subimpressis. Long. 3 m.m., lat. $1\frac{1}{3}$ m. m.

The subocular line is only very slightly developed in this species. It is remarkable by the conspicuous pubescence of the elytra; and I believe that this pubescence is variegated; for it appears to me to be of a dark colour on some of the black spots, while elsewhere it is pale. To which of the species here described it is most allied is not very clear; and it would perhaps be quite as naturally placed between *C. Huttoni* and *C. parviceps* as it is in the position I have adopted for it.

Professor Hutton has sent me a single individual of this species from Otago.

24. *Cyphon zealandicus*, n. sp.

C. neque elongatus, nec latus, densius pubescens, minus nitidus, ferrugineus, elytris plus minusve nigro variegatis; capite mediocri, crebrius subtiliter granulato, opaco; antennis haud elongatis, articulo tertio parvo, tenui, quam quartus duplo breviore, articulis 6^{o}–10^{m} singulis longitudine quam latitudo paulo majore; thorace majore, densius pubescente, obsolete punctulato; elytris crebre minus fortiter punctatis, basin versus subimpressis. Long. vix $2\frac{1}{2}$ m. m., lat. $1\frac{1}{3}$ m. m.

Though this species in appearance resembles *C. pictulus* more than it does any other species, yet it is readily distinguished from it and the preceding ones by the distinct subocular line. From all the other species with this character it departs widely by its greatly inferior size.

Four individuals have been sent from Tairua by Captain Broun.

25. *Cyphon suffusus*, n. sp.

C. brevis, latiusculus, haud convexus, subtilius pubescens, sat nitidus, ferrugineus, plus minusve nigro suffusus, antennis pedibusque testaceis; capite mediocri, confertim subtiliter granulato; antennis haud elongatis, rticulo tertio quam quartus duplo breviore; thorace elytris angustiore, subtilissime punctulato, basi utrinque vix sinuata; elytris sat crebre subtilius punctatis, versus basin sat distincte impressis. Long. 3 m. m., lat. 1½ m. m.

The elytra generally appear nearly black, with some ill-defined yellowish spaces behind the middle unsuffused with the black colour; the elytra, however, are sometimes quite black; and then the pubescence with which they are covered is easily perceived to be variegated, consisting of a very fine dark, and therefore indistinct, pubescence, among which patches of a paler colour are distributed. The subocular line is by no means acutely elevated.

Five individuals have been sent from Auckland by Captain Broun.

26. *Cyphon laticeps*, n. sp.

C. latiusculus, minus convexus, haud brevis, laxe pubescens, sat nitidus, ferrugineus, pectore corporeque superne plus minusve nigro-suffusis, elytris plus minus variegatis, antennis pedibusque testaceis; capite lato, confertim granulato; antennis sat elongatis, articulo tertio quam quartus duplo breviore; thorace majore, ad latera subtiliter granulato; elytris sat crebre fere fortiter punctatis, versus scutellum sat distincte impressis. Long. 4 m. m., lat. 2 m. m.

This species differs from *C. genalis* by its much more elongate form, and by the more distinct sculpture of the thorax and elytra. The coloration of the elytra is very variable; they may be said to be of an obscurely ferruginous colour, with ill-defined darker spots or patches. The subocular line is acutely elevated; but the space between it and the genal line is not so broad as in *C. genalis*.

This seems to be a species widely distributed in New Zealand. I have two specimens from Auckland, one from Tairua, and two others have been sent me by Professor Hutton as found in the province of Otago.

27. *Cyphon genalis*, n. sp.

C. latiusculus et convexiusculus, densius laxe pubescens, ferrugineus plus minusve infuscatus, antennis pedibusque testaceis; capite lato, brevi, densius pubescente, subtilius punctulato; antennis haud elongatis, articulo tertio parvo, quam quartus duplo breviore; thorace majore, lato, densius pubescente, vix punctulato; elytris crebre subobsolete punctatis, vix perspicue impressis. Long. 3 m. m., lat. 1½ m. m.

This is a short broad species, distinguished by the comparatively broad space between the subocular and genal lines; it is variable in colour, the elytra having an infuscate patch on the sides, which sometimes is largely extended; so as to suffuse most of their surface. The short pubescence is removed by extremely slight friction; so that it is rare to see an individual in perfect condition.

Sent in numbers from Tairua and from Auckland by Captain Broun.

Group 7.—Species 16 to 27 seem to me not to differ structurally from the European and North-American *Cyphon*; they exhibit the following characters:—

Small and short (or at any rate but little elongate) species. Head short and broad, the interantennal portion but little produced forwards. Antennæ never very long. Antennal fossa absent. Mandibles but little visible, being nearly entirely covered by the labrum. Maxillary palpi rather short, the apical joint short, shorter than the 3rd joint, and acuminate. Labial palpi not furcate. Front band of prosternum excessively reduced. Prosternal process very small, projecting but little behind the front coxæ, its termination blunt, not slender; it is placed at right angles with the middle piece of the prosternum; and the junction between the two is quite as prominent as the tips of the coxæ.

I am unable, as above remarked, to find any characters to distinguish these insects from the European *Cyphon*, as defined by C. J. Thomson and Mulsant. The New-Zealand species which present the above characters are very difficult to distinguish from one another; and I have drawn up the following Table to facilitate the discrimination of the species I have here described. It is well to add that this Table should not be trusted to by itself; for if so, it might mislead any one having before him a species I have not seen. It is also necessary to explain what I mean by the term "subocular line." If a European species of *Cyphon* (*C. variabilis*, auct., *e. g.*) be examined, it will be noticed that there is on each side of the head an acutely raised line extending from the base of the maxilla to the hinder and outer part of the head, and separating the dull or sculptured side of the head, in which the eye is placed, from the smooth and shining under surface of the head. If, then, the New-Zealand *Cyphon* be looked at, this genal line will be found in a similar position; but interposed between it and the eye will be observed another raised line, which is quite wanting in the European insect. This line is what I have referred to as the subocular line; the space enclosed between it and the genal line is smooth and shining.

Cyphon Huttoni .... *Cyphon parviceps* ..	Head narrow, no subocular line; granulation of head and thorax conspicuous; elytra deeply impressed a little distance behind the scutellum.
Cyphon pumilio .... *Cyphon arduus*	Head small, not elongate, not granulate, no subocular line; elytra not distinctly impressed.
Cyphon oscillans .... *Cyphon æqualis*	Head rather broad, not elongate, subocular line indistinct; thorax not granulate, elytra not impressed; form rather broad.
Cyphon graniger .... *Cyphon pictulus*	Head rather narrow, subocular line absent; thorax either very finely or quite distinctly granulate; elytra indistinctly impressed near base; form rather narrow.
Cyphon zealandicus .. *Cyphon suffusus* .... *Cyphon laticeps* .... *Cyphon genalis*	Subocular line distinct.

28. *Cyphotelus angustifrons*, n. sp.

C. elongatus, angustulus, parcius pubescens, sat nitidus, colore variabilis; capite angustulo, exserto, oculis prominulis, crebrius fortiter punctato; antennis elongatis, articulo tertio elongato, quam secundus longiore; prothorace transversim subquadrato, elytris duplo angustiore, anterius in medio truncato, lateribus crenulatis, anterius rotundatis, dorso inæquali, crebrius fortiter punctato, nitido, parcius pubescente; elytris elongatis, crebre, æqualiter, fortiter profundeque punctatis, nitidis, parcissime pubescentibus, humeris liberis, prominulis. Long. fere 6 m.m., lat. $2\frac{3}{8}$ m. m.

This singular insect does not at first sight suggest that it has an affinity with the other insects here described; for it is in appearance much more like the *Luperi* of the Phytophagous series of Coleoptera. It seems to be very variable in colour, one of the two individuals before me being nearly black all over, including the antennæ and legs, while the other is of a yellowish colour, with portions of the surface (notably the head, elytra, and ventral segments) more or less infuscate.

Two individuals have been found by Mr. Wakefield on the west coast of the Southern Island. I give below the chief structural characters of this isolated form.

Group 8.—Species 28 is quite isolated by the following characters:—

Parts of the mouth porrect; labrum transverse and exposed, separated from the front of the head by a distinct transverse membranous space; mandibles large; labial palpi slender, not furcate, the 2nd joint not dilated. Antennæ elongate, basal joint but little thickened, the space at their point of insertion not forming a fossa. Front coxæ subperpendicular, their apices projecting beyond the prosternal process; band of prosternum in front of the coxæ quite distinct, and less reduced than in any other of the New-Zealand species, although much smaller than it is in the European *Chrysomela cervina*, Linn. (*Dascillus cervinus*, Munich Cat.); prosternal process not forming an abrupt angle with the slender middle prosternal piece, its termination slender but distinctly prolonged behind the coxæ. Mesosternum without any triangular space in front in the middle to receive the prosternal process; the articulation of metasternum with mesosternum between middle coxæ incomplete.

This species is abruptly differentiated from the other New-Zealand species by the want of the cavity on the mesosternum, and by the less-reduced front band of the prosternum. The species makes a greater approximation to the Palæarctic *Dascillus* than do any of the other New-Zealand species, and may be treated at present as occupying a position intermediate between it and *Mesocyphon*.

VII.—*On the* Salenidæ, *Wright.*—Part III. *On a third Form of Recent* Saleniæ, *and on the* Saleniæ *from the Tertiary Deposits.* By Prof. P. MARTIN DUNCAN, M.B. Lond., F.R.S., &c.

SIR WYVILLE THOMSON has published two exquisite woodcuts of a form which he considers to be *Salenia varispina*, Agass., in his last work, which is more or less a summary of the scientific work done by the staff of H.M.S. 'Challenger' in and about the Atlantic *. The engravings, which must have been the work of a very skilled artist, may be assumed to be exact, or that, from the known difficulty of distinguishing the sutures of the part of the apical system remote from the madreporic plate, an error has crept in. The apical system (cut 32 †) is unlike that of *Salenia varispina* as drawn by Agassiz, and does not resemble that of any species of *Salenia*. When placed in the proper position, the engraving indicates that the subanal plate is placed as in a typical *Salenia*, and that the anal orifice, as usual, infringes on the generative plate posterior to the madreporic, and on that situated between the posterior ambulacra—that is to say, according to the accepted views of Lovén, the right posterior and the posterior genera-

* 'The Voyage of the Challenger:' "The Atlantic."

† Page 144. The reader of the book is directed to cut 31 for the delineation of the apical system, so interesting to biologists; this is a misprint for 32.

tive plates. But a new element enters into the composition of the encircling anal ring; for the right posterior ocular plate is made to fit in between two of the generative plates, and to form no inconsiderable part of it. If this is correct, the form has an atavism greater than that species which A. Agassiz named *Salenia varispina*, and which I have ventured to relegate to the genus *Peltastes* *; and Sir Wyville Thomson's species, which he considers to be *S. varispina*, Ag., has a relic of the genus *Acrosalenia* of the Jurassic age in its conformation.

The *Acrosaleniæ* have the right posterior ocular plate within the anal ring; and this peculiarity is noticed in specimens of all sizes. I have failed to notice it in small and young specimens of fossil *Salenia*.

Another point of difference between the type of *Salenia varispina* and the form delineated by Sir Wyville Thomson is the absence, in the last, of whorls of spinules on the great spines; for in the engraving on page 145 (no. 31) in the 'Voyage of the Challenger' longitudinal striæ occupy their place, and there is a serrate edge to the spines.

The locality whence the Salenid now under consideration was dredged was (according to Sir Wyville Thomson's book, page 144) to the south-west of Cape St. Vincent, in 1525 fathoms. He writes, "There were six specimens of a beautiful little sea-urchin with a small purple body and long white serrated spines, somewhat like those of the 'piper' of the Shetland fishermen (*Cidaris hystrix*)."

As there are six specimens, it will be very interesting to know whether they all belong to the form with the ocular plate intercalated. It is to be remarked that *Salenia profundi*, nobis, has a purple colour and that the spines are white: and probably it came from this locality; but on this point I am not by any means certain. There is some confusion about the number and localities of the *Saleniæ* dredged by the 'Challenger;' for Sir Wyville Thomson writes as follows (pp. 144 and 145, *op. cit.*) when treating of the characteristics of the Salenidæ:—"and I agree with Prof. A. Agassiz, who has referred a specimen of a species either the same as the one we dredged off the coast of Spain or closely allied to it, dredged by Count Pourtales in the Strait of Florida, to the Chalk genus *Salenia*, under the name of *Salenia varispina*." Either there was a dredging, the details of which have not been given, "off the coast of Spain," or the dredging of Jan. 30, 1873, south-west of Cape St. Vincent, is meant. Proba-

* Ann. & Mag. Nat. Hist. 1877, xx. p. 246.

bly this last is the only dredging which yielded *Saleniæ* in the European seas, and *Salenia profundi* and Sir Wyville Thomson's new form come from it.

On Tertiary Salenidæ.

Two species of *Salenia* have rewarded the careful search of labourers amongst the faunas of the vast Tertiary series. One species, and, I believe, but one specimen of it, was obtained by M. Pellat and described by Cotteau from the Nummulitic strata of Biarritz, and is clearly of Eocene age *; and one species, illustrated by several specimens of different sizes, was discovered in the cliffs at Aldinga, 26 miles south of Adelaide, South Australia, and was subsequently described and figured by Prof. Ralph Tate, F.G.S. &c. This species comes from the Middle Tertiaries of Australia, and was associated with fossils having the facies of the Murray-River beds. Prof. Tate remarks:—"The discovery of a Tertiary *Salenia* very happily bridges over the hiatus that separates in time the newly discovered living example obtained by Sir Wyville Thomson during the cruise of the 'Challenger.'" He describes the species, of which he sent four specimens to the Geological Society, as follows †:—

"*Salenia tertiaria*, spec. nov.—Form with the characters belonging to the genus, hemispherical, depressed, moderately inflated below, base concave; mouth not large, nearly circular; anus subhexagonal, disk with shagreen-like ornamentation, suranal plate smaller than the genital plates. Each interambulacral area with 12 crenulated tubercles in two vertical rows. Poriferous zones straight, ambulacral areas margined with large granules, between which are two rows of smaller ones, amongst which are scattered granulations.

"Diameter of the largest specimen $\frac{6}{10}$ of an inch, height $\frac{3}{10}$ inch."

Prof. Tate in his distant scene of labour and isolated from many sources of information, could not be aware of the existence of other recent species of *Salenia* or of Cotteau's tertiary type; but he, of course, recognized the peculiarity of his new form at once, and it certainly is remarkable for the number of the primary tubercles in the interambulacra and for the granulation of the ambulacra. As minuteness of detail is requisite for the purpose of comparing all these fossils, I make no

* Cotteau, "Echinides Nouveaux" Rev. et Mag. de Zoologie, Mai 1860, p. 222; and since this essay was commenced the Indian Survey have found a *Salenia* in Sindh.

† R. Tate, F.G.S., Quart. Journ. Geol. Soc. vol. xxxiii. p. 258, 1877.

apology for proceeding to analyze and compare, but express my hearty obligation to Prof. R. Tate for his giving me, in common with the Fellows of the Geological Society, the opportunity of studying his interesting specimens. There are four specimens of the species, the smallest being $\frac{4}{10}$ inch in breadth and rather more than $\frac{2}{10}$ in height; and there are two others which form, with the largest one (the type), a series as regards increasing size. All present a community of form, characterized by the relatively small apical system, the eccentric irregularly pentagonal vent, the large numerous interambulacral tubercles, and the ambulacra forming comparatively narrow zones having four vertical rows of small secondary tubercles. So far as growth is concerned, the specific characters so ably distinguished by Prof. Tate are well shown in all the specimens; and it would appear that there is a tendency with age to increase in height beyond the average breadth. Of course the number of the primary interambulacral tubercles increases with age, and the number and relative size of the ambulacral secondaries and pores also.

The small secondary tubercles of the ambulacra are more worthy of that term than that of large granules; for a careful examination shows each of them to have a non-crenulate mamelon with a small rounded imperforate boss. There is a marked distinction, during the growth, between the size of these secondary tubercles—a few remaining larger than the others at the actinostomial end of the narrow petaloid ambulacra. The outer vertical rows have these small tubercles larger and taller than the inner two rows; and there is an alternate arrangement of the four rows, the larger and external tubercles not being opposite to each other. The minute granulations of the ambulacra situated between and around the bases of the secondary tubercles resemble the pedicellaria-carriers of the recent types, and doubtless had this function. They are numerous and yet not crowded.

The pores, in pairs, are oblique, small, round; and the pairs are separated by a rounded ridge which starts from the outer side of each mamelon of every outer ambulacral tubercle; and there is a slight ridge between each pore in the pair. The pairs of pores in the smallest specimen number twenty in each zone, and from thirty to thirty-five in the largest. Five pairs of pores can be counted in relation to the large plates of the interambulacra, which carry the two largest tubercles above the ambitus. There is but one pair of pores to each ambulacral plate.

Some of the pores near the actinostome have a circular rim to the pair.

The actinostome is contracted, small for the size of the test, and smaller in extent than the apical system; and the cuts are very small.

Each interambulacrum at the ambitus is at least four times as broad as the ambulacrum in the same region, and the median space is crowded with small secondaries and interspersed granulations; the largest of the secondaries cling to the margins of the scrobicular circles of the great tubercles. This crowding of small tubercles looking like large granules, flat and broad, and not high or crenulate, and imperforate but with distinct mamelon and boss, and without a "circle," the base being flush with the test, gives a very marked appearance to the test. Large and small secondaries and granulations to the number of about 100 fill up the median space flanked by the great primaries. The small granules are in the midst.

Each large primary has a wide plain boss, crenulate at the shoulder, with fourteen minute tubercles in a circle. The mamelon is round, small, and imperforate. The base of the boss is within a slightly elliptical scrobicule, which is below the level of the median interambulacral space. The scrobicular-circle edge has the largest of the small secondaries sparsely distributed around it laterally. Above and below these are the sharp eminences of neighbouring circles merging one into the other. A few granulations are upon the edge here and there, and especially on the side of the circles in contact with the ambulacra, where the secondary tubercles are not well represented. There is a slight circular ridge within the limits of the scrobicular circle as in the larger tubercles.

Most of the mamelons are truncated cones; but in the younger specimens of the *Salenia* they are sometimes rather convex at the sides.

The smaller primaries are slightly more convex in outline than the others; and their bosses are surrounded by a flat circle, Their secondaries and granules in contact with the ambulacral margin are more decided and numerous than in the larger tubercles. The small primaries are in two vertical and approaching rows below the ambitus; and the largest there is about the size of the smallest primary close to the apical disk in some interambulacra. The median interambulacral space is broad, on a lower level than the ambulacra, and looks wavy to the naked eye. On either side of it are the vertical series of the five secondary tubercles on the scrobicular-circle edges, and in the middle are two or somctimes three rows of small secondaries with granulations: these come down close to the peristome; and the lowest are just above the lowest smaller primaries. Close to the apical system, in the interambulacra, are usually extensions of the median system of small tubercles and granules; and they are most numerous above the primaries which are remotest from the disk's edge. The apical disk, irregularly pentagonal in shape, is larger than the peristome, but is small in relation to the test. It by no means covers the whole abactinal surface of the test; and its surface is nearly flat, the only elevation being in the region of the subanal (preanal) plate, which slopes up to the anal orifice. The ratio of the diameter of the apical system to that of the test diminishes with age; and the youngest specimen has the disk more convex than those of the others. The oblique anal opening, as a whole, is more elevated than the rest of the disk; and its raised edges include an irregular pentagonal area whose long diameter is parallel with the free edge of the nearest ocular plate (the right posterior). The sharp, rounded, thin, irregular anal edge is most distinct in the young specimen, and is composed in every one by the joined everted edges of the plates composing and surrounding the orifice. The plates infringed upon by the anus and composing its edge are the right posterior generative and the posterior generative plates and the sub- or preanal plate; for the madreporic plate or the right anterior, the left anterior, and left posterior or lateral generative plates do not reach the orifice.

The three anterior generative plates (that is to say, the madreporic, the left anterior, and the left posterior or lateral) are the largest in the young specimen; but with age the right posterior becomes equal to the madreporic; and the other two, the right posterior and the posterior, are different in shape from the others. There is but slight difference in the relative sizes of the larger plates. The madreporic plate is seven-sided, is roundly pointed externally, where it infringes slightly on the median interambulacral space; the plate is longer than broad, the greatest breadth being internally. The free edge is slightly waved. The sutural margins are distinct and linear; and the pits are round or lozenge-shaped in outline, deep, and become more numerous with age. There is always one at each sutural angle, and an extra one in the midst of the antero-posterior suture, from the rear of the anterior ocular plate to the preanal; but in most of the specimens there is also one in the suture which divides the plate from the right posterior. The madreporic body has, as usual, been lost; but the scar is large and elongate. The left anterior plate resembles the madreporic, has a well-marked central generative pore; and there is a pit in the midst of its suture with the preanal. The left posterior plate, slightly smaller, has a well-marked generative pore, and greatly resembles the others already noticed. It has a pit in the midst of its suture with the preanal, and another in the suture with the posterior plate. In all these plates there are pits at the angles also.

The preanal plate is six-sided and smaller than the others; it rises to a rim-edge with a slight extra elevation where it bounds the anus; and this edge is concave and almost angular. The sutural lines in contact with the anal rim are the shortest; and the others are nearly equal to each other in length. All except the two shortest have an extra pit in the midst.

The posterior plate has a rim-edge bounding the anal orifice; and the pore is situated where the ridge begins to rise from the body of the plate, or in the ridge itself. Resembling the anterior plates in general configuration, it is broader at its base, where it conforms to the figure of the right posterior plate, with which it is in lateral contact to the right. The right posterior plate resembles in general outline the left posterior, but it has the same structure as the posterior internally; the rim is stout, and the pore is either in it or at its base. In some of the specimens this plate is the smallest.

The ocular plates are well developed and are subequal. The external margin is long trilobate, and, on the whole, straight; the central lobe is often incised, and the outer ones slightly pointed. The outer edge is slightly raised and hides the ocular pore; and the edge forms a slight rim to the whole plate, so that there is a hollow on the top and internal to the margin. There are four sutures in relation to each plate, and two short edges which unite the marginal edge with the generative plates. Internally the plates are pointed and arise in the sutural angles of the generative plates. The right posterior ocular plate has its internal point close to the edge of the anus, the rim being traversed by a very short suture between the generative plates. Hence this ocular plate comes close to but does not enter into the composition of the rim. The sutures which are in relation with the ocular plates, except the last noticed, point to a spot on the preanal disk, very slightly posterior to a line drawn from one posterior poriferous zone of the antero-lateral ambulacrum to the other. The external straight edge of the ocular plate is in advance of the angular end of the generative plates on the pentagonal outline of the disk. The generative pores are surmounted by a rim.

The ornamentation is stated by Prof. Tate to be like shagreen; and this fine irregular microscopic structure is well seen here and there. It is very irregular and minute, and covers the small rounded and more or less eccentric rings of ill-defined swelling that cover the plates more or less. Sometimes radial lines and radial swellings exist; but all the ornamentation is very indistinct. There is not a trace of a granule or of a tubercle's base on the disk.

The larger specimens of this interesting species are $\frac{6}{10}$ inch or slightly less in breadth at the ambitus, and $\frac{3}{10}$ to $\frac{4}{10}$ inch in height. It is a fine form of *Salenia*, with all the characters of the Cretaceous species, except the distribution of the pores in the ambulacra. In the older *Saleniæ* there is a pair of pores to each ambulacral tubercle, and one intermediate; or, in other words, two pairs are in relation to each tubercle. The *Salenia* described by Prof. Tate has but one pair. This is the case with the recent species of Salenidæ, so far as is known. The drawing of a form by Sir Wyville Thomson does not give the required information; neither does the context.

The specific distinction of *Salenia tertiaria*, Tate, which relates to the number of primary tubercles (in all stages of their growth) in the interambulacra, allies it with the recent forms more than with the Cretaceous; and the comparative flatness of the apical rim separates it, with the character just mentioned, from the *Salenia petalifera*, Agassiz (1838), so common formerly in the Upper Greensand and Chalk Marl of this country. The contour of the test of the Australian form is between that of *Salenia geometrica*, Agassiz (1838), of the Upper White Chalk, and that of *Salenia petalifera*; but it is not so high as the first in relation to its breadth. But the Upper-Chalk form has as many primary tubercles as the Tertiary species.

Salenia from the Eocene.

Cotteau described a well-marked species of *Salenia* from the Lower Nummulitic formation of Biarritz in 1860. His interesting description did not escape the research of Dr. Wright, who refers to the fact in his monograph on the British fossil Echinodermata from the Cretaceous formations (Pal. Soc. vol. i. pt. 4, p. 149, 1871).

The following is a rendering of M. Cotteau's description (Rev. et Mag. de Zoologie, Mai 1860, p. 222, "Echinides Nouveaux ou peu connus," par M. G. Cotteau, plate xiii. figs. 11–14):—

Salenia Pellati, Cot.

The test is small, short, circular in outline, slightly swollen above, and almost flat on the actinal surface. The interambulacra are broad, and are ornamented with two rows of tubercles (primaries), four or five in a series. They are strongly crenulate, and have a projecting and imperforate mamelon. They are very unequal in size; and only one or two in each series above the ambitus are largely developed. Granules are scarcely unequal, distant, and sometimes have mamelons, and they form a double subsinuous line in the midst of the interambulacrum.

The ambulacra are very narrow, not flexuous, and are furnished with two rows of small granules, eleven or twelve in a series; they are alternate or but slightly distant; and there are some intermediate wart-like grains. The pores are simple openings at the base of a small granule-like swelling.

The apical disk is relatively large, has five genital and five ocular plates, which are perforate, and an imperforate subanal. These plates are marked with numerous radiating grooves or furrows, which give them a very remarkable digitate appearance ("un aspect digité"). The anus is eccentric in front, is triangular and slightly swollen at the margin.

The peristome is depressed, slightly smaller than the apical system, subdecagonal, and tolerably distinctly marked with cuts. Height 3·5 millims., diameter 6 millims.

Cotteau remarks that this small species is more or less allied to the Cretaceous forms, and instances *Salenia scutigera* and *S. minima* of the Chalk of Maestricht and Ciply. The distinction is in the relatively large peristome and in its projecting ambulacral tubercles and grooved disk.

This *Salenia* is quite typical of the genus. The subanal plate, when placed in its proper position in relation to the madreporic, determines the eccentricity of the anus to be posterior and to the right. M. Cotteau's drawings add to the information given in his context; for they show that the number of pores is about double that of the number of ambulacral tubercles, and that the posterior and the right posterior generative plates are the largest. Hence there are two sets of pores to each ambulacral tubercle, instead of one, as in the subsequent *Saleniæ*. The ocular plates, of course, do not enter into the formation of the anal ring, which infringes on the usual plates. The dimensions of the peristome and the size of its cuts are characteristic.

Salenia Pellati is therefore more closely allied to the Cretaceous than to the Miocene or recent forms, the small number of pores, as A. Agassiz has pointed out, being characteristic of the Cainozoic and recent forms.

Doubtless only a short time will elapse before a description of the lately discovered *Salenia* from the Nummulitic of Sindh will be given to science.

VIII.—*The Foraminiferal Nature of* Haliphysema Tumanowiczii, *Bow.* (Squamulina scopula, *Carter*), *demonstrated.* By W. Saville Kent, F.L.S., F.Z.S., &c.

[Plates IV. & V.]

In the 'Annals' for January last I discussed at some length the nature and affinities of Prof. Haeckel's newly-instituted group of the Physemaria, an assemblage of organisms embracing, in accordance with the views of its talented author, the *Haliphysema Tumanowiczii* of Bowerbank and the *Squamulina scopula* of Carter—two forms, however, which, while generically separated by Haeckel, are now generally admitted to be specifically identical.

My chief object in the communication referred to was to show that these Physemaria, if structurally agreeing with the figures and descriptions submitted by Prof. Haeckel, must be regarded as simple sponges, the slightly modified equivalent of a single monad-lined chamber or ampullaceous sac of the more complex sponge-forms,—as also that the *Squamulina scopula* of Mr. Carter, if identical with these Physemaria, can no longer be retained in the class of Foraminifera. On the other hand, I upheld the necessity of accepting Mr. Carter's foraminiferal interpretation of this organism, should a closer investigation demonstrate the absence of those typical flagellate cells or zooids which Prof. Haeckel represents as constituting the inner lining of the several Physemaria he figures and describes.

In the following (February) number of the 'Annals' Mr. Carter still more emphatically maintains the foraminiferal nature of his *Squamulina scopula*, and for a second time repudiates Prof. Haeckel's soft impeachment as to its affinity with his newly-created Physemarian group. Whether or not the organism encloses collared flagellate monads, Mr. Carter is not in a position to determine; but, in either case, he insists that the polythalamous character of the test or exoskeleton is alone sufficient to demonstrate its foraminiferal affinities. In the April number of the same magazine the Rev. A. M. Norman has taken up the thread of this disputed relationship, and, as the fortunate discoverer of the most interesting type of the genus, *Haliphysema ramulosum*, Bow., in addition to being personally familiar with the particular subject of contention, *H. Tumanowiczii*, is in a position to discuss the question with especial authority. Having, moreover, compared specimens of *Squamulina scopula*, received from Mr. Carter, with Dr. Bowerbank's typical examples of the last-named form, he pronounces the same to be absolutely identical.

Mr. Norman at the same time draws up a proposed revision of the nomenclature and characteristics of the several species apparently agreeing structurally with *Haliphysema Tumanowiczii*, in which he declares this form, together with the *Haliphysema primordiale*, *Gastrophysema dithalamium*, and *G. scopula* of Prof. Haeckel, to be mere variations of one and the same type. Premising that Prof. Haeckel's assertions concerning the lining of the body-cavity of this species with flagellate cells (my own and H. James-Clark's collar-bearing monads) shall be substantiated, Mr. Norman has no hesitation in retaining the genus *Haliphysema*, as originally proposed by Dr. Bowerbank, among the sponges. Mr. Carter's negative characters of the polythalamous nature of the internal cavity and the extrusion of pseudopodic processes from the cut and mutilated edges only of the divided organism, he agrees with myself to be too slender a foundation, in face of the positive evidence, if substantiated, of the flagellate cells as represented by Haeckel, upon which to further entertain its affinity with the Foraminifera. Unfortunately, Mr. Norman has no further testimony to submit concerning the ultimate internal structure, as exhibited in the living state, of either this or any other of the several allied types included in his revision of the genus *Haliphysema*, but which, as already intimated by Mereschkowsky, at the conclusion of his description of a new sponge (?), *Wagnerella*, in the 'Annals' for January 1878, is absolutely requisite for the correct and decisive determination of its true relationship.

Since taking up my residence in the Channel Islands a chief object of my ambition has been the discovery and examination in the living state of some member or another of this anomalous genus *Haliphysema*. The extraordinary wealth of both the sponge and foraminiferal fauna of this coast-line seemed to yield promise of a successful issue to a continued search, and more especially since one species, the *H. ramulosum*, was originally obtained by Mr. Norman from the neighbourhood of Guernsey. My aspirations in this direction have at length been rewarded. On the 18th of April last I was fortunate enough to find *Haliphysema Tumanowiczii* in tolerable abundance on the fronds and root-stalk of *Maugeria sanguinea*, and was thus enabled in the course of a few days to completely satisfy myself as to the nature of this type. Previous, however, to entering into a detailed report of this recent examination of living specimens, a short space must be devoted to an account of the results of a still earlier personal acquaintance made with this same form in a preserved and dried condition. Some few years since, when an attaché to the natural-history departments of the British Museum, Mr. Carter was kind enough to present me with an admirably prepared slide, dry-mounted, of his so-called *Squamulina scopula*, including also a fine example of the branching variety, since identified with the *Haliphysema ramulosum* of Dr. Bowerbank. Although sorely tempted on many occasions to raise the glass cover from this slide, and immolate one of these typical specimens on the altar of science, the anticipation that I should shortly encounter the same in the flesh on the Jersey coast, proved, for a while, a sufficient restraint, and the slide in consequence remained intact. The still more powerful influence, however, of hope long cherished but unrewarded at length asserted its more potent sway; and selecting that example of the solitary and typical form which could best be spared from the little group, it was carefully removed for examination. This preliminary investigation of a dried specimen only, however, was not destined to definitely solve the question. Dried sarcode was found running out upon and adhering to some of the spicules that bristled upon the external surface of the organism in a manner as nearly as possible identical with that which characterizes the dried syncytial element of many ordinary sponges. Within the interior there was likewise encountered one or more minute fragments which bore a strong resemblance, under a magnification of 800 diameters, to a pavement-like arrangement of the essential collar-bearing spongozoa in a desiccated state. At the same time a large portion of the internal cavity of this organism was occupied by a yellow granular substance scarcely corresponding with the syncytial or cellular element of ordinary sponge structure, and the presence of which to a certain extent negatived that portion of the evidence favourable to the sponge interpretation. Rising from this preliminary "vision of dry bones" we were nevertheless still loyal to the impression derived from Prof. Haeckel's account and figures of his Physemaria, and anticipated an easy demonstration of their true sponge-nature as soon as an opportunity of examining living specimens should arrive.

The investigation of the dried example just described took place in February last; and, as may be anticipated, no small amount of pleasurable excitement attended the first acquaintance, made in the following April, with the same form in the full vigour of its existence. Specimens were in the first place transferred to a shallow zoophyte-trough, and cursorily reconnoitred with a power of from 100 to 200 diameters only. This preliminary inspection yielded no positive results, the spicule-bristling capitulum in each instance maintaining the mute stolidity of the Sphinx itself and altogether refusing to yield up its secret. In one or two instances, however, there was the ghost of an appearance of syncytium-like sarcode embracing the base of some of the larger spicules. At the same time (and this must be accepted as a somewhat significant fact) not the slightest inward or outward current from the terminal orifice or any other region could be detected on adding a solution of carmine to the water, which may be almost immediately observed when experimenting in a similar manner on a living sponge. Proceeding now to a more intimate acquaintance with the organism, a lucky cut with a dissecting-knife had the gratifying result of dividing a specimen evenly and longitudinally from one end to the other; and this, submitted to no higher a magnifying-power than the one previously employed, at once solved the riddle. Cord-like prolongations of moving granular sarcode were seen at the severed edges extending from one to another of the projecting surfaces of the quartz granules or spicular fragments of which the skeletal framework was composed. Here and there these cord-like prolongations were, as it were, knotted into fusiform or globular dilatations; and these, by the contraction in opposite directions of the thinner portions, were now and then drawn slowly across from one end to the other of the same. The sarcode substance of the more interior portion corresponded closely with that of the knotted dilatations, except that in this more densely aggregated condition it presented a darker amber-like aspect. In a little while still finer thread-like extensions of this sarcode were thrust out from the denser mass, some as slender, attenuate, simple filaments, while others assumed a more or less branching form. Here and there the ramifications of these latter came into contact and anastomosed with one another, while in all was maintained a circulation of the granular contents identical in all ways with what obtains among the typical Foraminifera, such as *Miliola* and *Rotalia*. A still more rigid examination with the aid of a magnifying-power of from 800 to as much as 2000 diameters failed to reveal the existence of any structures corresponding with the collar-bearing flagellate zooids of ordinary sponges, or, indeed, of any separate cellular elements whatever. Occasionally the globular or fusiform sarcode dilatations already mentioned exhibited, under this increased magnifying-power, the presence within their interior of a nuclear-like body and sundry vacuoles, as represented in Pl. IV. fig. 11. Beyond this, all consisted of a homogeneous interblending and adherent granular sarcode, showing in its attenuate condition that granule-circulation just described. The Foraminiferal nature of the organism and the accuracy of Mr. Carter's first deductions relating thereto were now therefore established beyond dispute.

It yet remained to witness the vital manifestations of this interesting type under its normal and undisturbed conditions. Placing a small group apart, and leaving them to themselves for a short space, a re-examination a few hours later resulted in the detection, in several instances, of slender sarcode prolongations issuing from the apical aperture and running out over the surfaces of the spicula which entered so conspicuously into the composition of the distal extremity of the test. In one of the more prominent of these examples (Pl. IV. fig. 5) this sarcode was excurrent to a still greater extent, spreading in a film-like manner over the bases of these spicula, and extending at various points into the surrounding water as shortly branching prolongations, which exhibited the characteristic circulating movements. Later on, a specimen was encountered that has served to throw considerable light on the alimentary capacities of this organism. A mass of granular sarcode was here seen collected outside the terminal aperture of the test, and adherent to it by the appendages of the left side of the body the nauplian larva of some, probably epizoic, crustacean. The little fellow was struggling violently to escape, but was evidently as securely trapped as ever a bird on a lime-covered twig. Gradually the life-struggle became weaker and weaker, and the little nauplius more deeply immersed in the tenacious sarcode of its captor, the whole body and remaining appendages, indeed, becoming completely enveloped within the next few hours. Pl. IV. fig. 2 represents the upper portion of the test of this specimen with the entrapped nauplius, shortly before its complete immersion. On the following morning, about ten hours later, the capture of the preceding day still occupied a closely approximate position outside the aperture of the test, but was reduced by the process of deglutition into an oval, apparently homogeneous, and altogether irrecognizable mass. The sarcode of the foraminifer, on the other hand, evidently stimulated into active life through the access of this hearty meal, presented now a degree of extension and vitality that had not hitherto been witnessed. While a portion of this remained collected around the semidigested food-substances, the greater part was excurrent in the form of slender ramifying and frequently anastomosing pseudopodia of gossamer-like tenuity; these extended beyond the field of view in every direction, and in many instances formed a junction with neighbouring foreign bodies. The aspect of the organism in this active condition of vitality, and as represented in Pl. V., may be most appropriately compared to that of a beaded spider's web, endowed throughout its mazy extent with sentient life, and exhibiting in every thread an outflowing and inflowing stream of its constituent granules. The fabricator of the web, in further pursuance of this simile, may be imagined as occupying the cavity within the test, but having no occasion to rush out and pounce upon its entangled prey after the manner of a terrestrial spider, this being in due course brought to it from the most outlying ramification of the web by the never-ceasing centrifugal and centripetal circulation. Here and there a small particle, suitable for food or for the further fabrication of the test, might be seen in such a manner entangled, as at *b b b* of the same Plate, and gradually travelling with the flowing sarcode towards the terminal aperture of this structure. The extension of the sarcode as a thin web-like expansion, while witnessed on several subsequent occasions, was rarely seen to attain so luxuriant a development as was exhibited in the present instance.

The foraminiferal nature of *Haliphysema Tumanowiczii* being now established beyond question through a full investigation of its vital manifestations, brief attention may be directed to the characters presented by the external test or skeletal portion. In this direction there is found associated with the specimens gathered on the Jersey coast a considerable amount of deviation from the typical form first described and figured by Mr. Carter in the pages of this journal. Passing over the internally septate and dome-shaped basis of attachment, which has been already described with sufficient accuracy by Mr. Carter and is persistent in its character, the test, as it occurs here, is, in the majority of instances, more elongate and irregularly shaped, and in many cases considerably contorted. Neither on any occasion has there as yet been encountered a specimen marked by the deep annular constrictions delineated by Mr. Carter, and which are, indeed, by no means so clearly defined as represented in his sketches in those type examples kindly placed by him some years since at my disposal; Mr. Norman's experience in this particular apparently agrees with my own. That these Jersey *Haliphysemata*, however, are identical with Mr. Carter's type, or rather with the original *Haliphysema Tumanowiczii* of Dr. Bowerbank, there can be but little doubt, every gradation being traceable, from the simply clavate and slightly bent form originally figured and described by Dr. Bowerbank (Brit. Spong. vol. i. pl. xxx. fig. 359), to the elongate and much-contorted shapes above referred to. That the more attenuate contour of the Jersey examples is due, to some extent, to the greater rapidity of the currents to which they are exposed, may be submitted as a reasonable conjecture; but it is at the same time certain that we have here an organism tied down by no hard and fast lines of specific immutability, but one inheriting a most extensive range of morphological variation. Several plates might with the greatest ease be occupied in the delineation of the innumerable polymorphic aspects presented by the variously constructed domicile of this undoubtedly clever little artificer; but a few figures only, to which reference may now be made, suffice for the representation of the more remarkable of these.

The form represented by fig. 6 of Pl. IV. may be accepted as one of the more simple expressions of this specific type as met with upon the Jersey coast, and as the one that approximates most closely to the type upon which Dr. Bowerbank originally founded the genus *Haliphysema*. The projecting spicules artificially incorporated in the test of this specimen are certainly not so numerous as in that type form, and are disposed with greater irregularity upon its surface. These spicules are indeed, as in all the other examples here delineated, mostly replaced by a suitable building-material more readily and abundantly accessible, consisting of the angular quartz granules of every size and form derived from the disintegration of the adjacent granite. This slight variation in the composition and arrangement of the building-constituents affords, however, no sound basis for specific discrimination, representing in this case a mere adaptation to circumstances, and demonstrating the capacity of the little architect to, as it were, make his bricks without straw, and to turn to equally good account whatever material, sufficiently adapted to the purpose, may fall within his reach. Not unfrequently specimens occur most nearly resembling the form just referred to, but in which the wider distal region is not reflected to one side, but presents a simply short, erect, and clavate outline, corresponding, under these circumstances, with a small example of Mr. Carter's typical *Squamulina scopula* included in the slide placed by him at my disposal. A third modification of this same variety is likewise encountered, in which the more inflated distal portion assumes a perfectly globular outline. This variation, with its short slender pedicle and terminal *chevaux de frise* of radiating spicula, presents an aspect so closely coinciding in external contour with Prof. Haeckel's *Haliphysema echinoides* (Biolog. Stud. p. 186, pl. x. fig. 127) that, making due allowance for the variation in the spicular armature—a feature entirely dependent on the local surroundings of the organism,—it is impossible to repress the suspicion that this accredited species is a mere local variety of the type now under discussion. To place the *Haliphysema globigerina*, Haeckel (the test of which is constructed of *Globigerina*, *Textularia*, and other foraminiferous shells, mixed with those of Polycystina), in the same category, would at present, perhaps, be rather a bold step. It may at the same time be remarked that the shells of various Foraminifera, such as *Miliola* and *Rotalia*, are not unfrequently found incorporated among the quartz grains and sponge-spicules in the test of the present species, and as, indeed, indicated in the example represented in Pl. IV. fig. 6. It has further to be added that *Haliphysema Tumanowiczii* apparently enjoys a considerable bathymetrical range, as, in addition to taking it close to the shore-line, it has been fished up by me at a depth of over 20 fathoms off this same coast, and may probably extend to those abyssal depths where Globigerinæ and other foraminiferous shells afford the most abundant building-material for the construction of the test. Proceeding to an examination of the more attenuate variations of this species, the elongate, bent, and somewhat irregularly clavate form delineated in fig. 1 may be said to represent the most simple and typical example; fig. 5, as also fig. 2, whose truncate distal extremities, however, indicate their as yet immature condition, are shorter and rather thicker modifications of the same variety. In all of these the diameter of the test increases with a moderate amount of uniformity in proportion to its linear extension, there being no sudden marked dilatation of its calibre either distally or at any intermediate portion of its course. Figs. 3 and 7 of this same Plate exhibit a marked deviation from the preceding examples. The initial or pedicle portion is here still more elongate and remarkable for its sinuous and contorted contour; surmounting this succeeds a dilated subglobose capitulum, corresponding with that already referred to as not unfrequently associated with the short straight-stalked variety most nearly approaching Haeckel's *Haliphysema echinoides*. All the varieties so far enumerated are found to merge gradually into one another, and thus form a single gradational series, all again occurring in close proximity on the same frond of seaweed. One singular example encountered in association with the foregoing, and which must without doubt be regarded as an abnormal form, remains to be described. As shown in the illustration of this specimen (Pl. IV. fig. 4), the long spicular elements represented more or less abundantly in all the other examples are here reduced to a minimum, the entire test being finely granulate, with here and there a few larger quartz grains or spicular fragments. The most remarkable deviation, however, is associated with the form of the test itself, which consists of a wider, compressed, and semicordate distal expansion or capitulum mounted on an abruptly sinuous and somewhat nodose pedicle. The contour, as a whole, of this aberrant type so closely corresponds in shape and size with that of a single calcareous tube of the Polyzoon *Anguinaria spatulata*, found abundantly in the same neighbourhood, that the possibility is suggested of the Foraminifer having seized upon such a tube, in its deserted state, as a basis for the construction of its domicile.

Through the artificial preservation for several weeks of examples of *Haliphysema Tumanowiczii* in a living and healthy state, some knowledge of its developmental history has been arrived at. Attention was first attracted to the presence in close proximity to the adult indivduals of minute pedicellate and mostly pear-shaped organisms measuring only from one sixth to one quarter of the height of the latter. Examined closely, these were found to consist of yellowish granular sarcode identical with that of the adult specimens, from which, by a process of fission or gemmation, they were evidently derived. In the smaller examples (Pl. IV. fig. 8) the surface of the periphery was entirely smooth, naked, and unbroken; but in rather larger ones (fig. 9 of the same Plate, greatly amplified), slender, short, and slightly branching pseudopodic processes were observed radiating on all sides, representing the rudimentary condition of the attenuate anastomosing pseudopodia of the adult types. Subsequently every gradational step from this naked pyriform zooid to the test-constructing and matured condition was observed, as also an earlier and more rudimentary phase than either of those just mentioned. This earlier phase will be found represented in Pl. IV. fig. 10, and may be compared to a free-moving turgid *Amœba*, of yellowish colour and granular consistence, which, after a brief nomadic state, settles down and develops through the naked pedunculate forms into the characteristic testaceous type.

Haliphysema Tumanowiczii having now, it may be anticipated, found a permanent resting-place among the arenaceous, and in this case adherent, test-building Foraminifera, represented by Dr. Carpenter's family of the Lituolida, it yet remains to be decided whether the Haeckelian species *H. primordiale*, *echinoides*, and *globigerina*, as also the bilocular expression of the same form, *Gastrophysema dithalamium*, must not be relegated to the same category. Mr. Norman (*l. c.*

p. 274) has considered himself justified in regarding both the first and last of the four types enumerated as mere varietal phases of the present species; and by the evidence adduced in this communication, so far as the characters of the external test may be depended on, the two remaining ones, and more especially Haeckel's *Haliphysema echinoides*, are but similar locally modified varieties of the same. The final solution of this question, however, is necessarily dependent on the future confirmation or otherwise of Haeckel's interpretation of the internal structure of these four so-called species. Truly, as already insisted in my former communication, if, as he represents, the internal cavities of these organisms are lined with collar-bearing flagellate cells or monads*, their sponge nature is undoubted, and we have in these merely remarkable isomorphs or external facsimiles of the Foraminiferal type. In this case, it is almost needless to remark, a new generic title will have to be substituted for the sponge-form, the name *Haliphysema* being retained for the Foraminifer. At the same time, however, it is requisite to remark that two at least out of the four species enumerated by Haeckel, the deep-sea *H. echinoides* and *globigerina*, have not been examined by him in the living state, and that therefore his delineation of their internal structure must border close upon, if indeed it does not belong altogether to, the realm of the ideal. Correlating this with his representation of the ciliated gemmules of the calcareous sponges as consisting of an outer and inner, or epiblastic and hypoblastic, cellular layer, the latter of which is now demonstrated to possess no real existence, it is impossible to accept without considerable mistrust his representation of a parallel internal cellular layer in the minute organisms now under consideration. Prof. Haeckel has, moreover, gone so far as to say (Biol. Stud. pp. 192, 193) that examples of *Haliphysema Tumanowiczii*, obtained by him on the Norwegian coast, exhibited a similar bilaminate structure, an assertion now demonstrated by both Mr. Carter and myself to have no factual basis of support.

It is to be hoped that Mereschkowsky will favour us with

* With reference to the oral aperture of the collar-bearing monads characteristic of all sponge forms, and occurring abundantly, as I have recently shown, as independent organisms, Mr. Norman (*l. c.* p. 271) has misinterpreted my views in his quotation from my communication. In this he makes me characterize the collar itself as the oral or interceptive organ; by quoting a little further, however, he would have found that I relegate the oral or inceptive functions not to the collar, which is the trap or hand to seize, but to the entire distal extremity of the body, circumscribed by the base of the collar, the sarcode in this region being softer than elsewhere and freely admitting the passage of food-matter.

full details of the internal structure and vital phenomena of the *Haliphysema*-like organism figured and described by him in the 'Annals' for January last, under the title of *Wagnerella borealis*, and which, upon the strength only of the presence of apparently self-secreted shortly acerate spicula within the substance of the periphery, he pronounces to be a sponge-form. In the preceding number of the same magazine, however (December 1877), Mr. Carter describes an undoubted foraminiferous type, upon which he confers the name of *Rotalia spiculotesta*, the external test of which is chiefly composed of similar-shaped self-secreted spicules.

Channel-Islands Zoological Station,
St. Heliers, Jersey, June 7, 1878.

EXPLANATION OF THE PLATES.

Plate IV.

Figs. 1, 3, 5, 6, 7. Various modifications of the test of *Haliphysema Tumanowiczii*, as described in the text; enlarged 40 diameters. At fig. 5 pseudopodic processes and film-like extensions of the internal sarcode are protruded from the terminal aperture and spread over the skeletal framework.

Fig. 2. Upper portion of a specimen, exhibiting at *a* the entanglement in the sarcode of the nauplian larva of some crustacean.

Fig. 4. An abnormal example of the same species, which has apparently adopted the deserted tube of the polyzoon *Anguinaria spatulata* as a foundation for the construction of its test.

Fig. 8. An embryonic and naked condition of the same species, enlarged 100 diameters.

Fig. 9. A slightly more advanced phase of the preceding, previous to the construction of a protective test, and in which short pseudopodia are produced from the surface of the periphery; enlarged 200 diameters.

Fig. 10. The earliest embryonic condition of *Haliphysema Tumanowiczii* observed, in which the organism presents the aspect of a free-moving *Amœba*; enlarged 250 diameters.

Fig. 11. Small portion of pseudopodium, with fusiform dilatations, as exhibited on cutting a specimen open; enlarged 2000 diameters. A nucleus-like body and several vacuolar spaces are apparent in the upper and larger of these dilatations.

Plate V.

Upper portion of the specimen of *Haliphysema Tumanowiczii* delineated in fig. 2 of the preceding Plate, with the pseudopodia in their fully extended state, and exhibiting at *a* the nauplius (previously figured) in a semidigested condition. Other organic particles captured in the web-like network of the anastomosing pseudopodia are indicated at *b b b*. Enlarged 100 diameters.

IX.—*On the* Nauplius *Stage of Prawns.* By C. Spence Bate, F.R.S.

It is now fifteen years since Fritz Müller published his memoir "Die Verwandlung der Garneelen," in the Archiv f. Naturg. 1863. In this he announced that he had discovered that the prawns, more especially mentioning *Penæus*, commenced life in a stage closely approximating to that in which the Cirripedes and some entomostracous Crustacea did, in that which is now known as the *Nauplius* form. Fritz Müller's high reputation as an accurate observer and philosophic naturalist induced carcinologists to accept his statement, although, as I stated when reporting on his memoir in the 'Zoological Record' for 1864, "in the chain there are one or two links wanting to make the connexion perfect," adding, in a note, that "since this passage has been in type, Dr. Müller informs us that the several links in the progressive development have been established by him, closer than, for want of space, he has been able to demonstrate in his work;" and I further added, at page 283 of the same 'Record,' "The difficulty of preserving the life of these delicate creatures has not yet been overcome. The newly hatched larva from the commonest and, we might assume, the hardiest crabs has not been preserved beyond the second stage. . . . It is therefore not to be demanded that Dr. Müller should succeed beyond the step at which others have stopped. It is only necessary for him to show assimilation of conditions to enable us to accept his conclusions."

Knowing that Captain Du Cane had, as far back as 1839, published, in the second volume of the 'Annals and Magazine of Natural History,' p. 168, pls. vi. & vii., the character and form of the young of *Palæmon*, and having also myself observed that the prawns on our coast, as far as I had examined them, exhibited no such character of metamorphosis, I, during my correspondence with Fritz Müller, suggested that the important link wanting was the connexion of the *Nauplius* with the parent, not, as he says, "the relation of the *Nauplius* with the *Zoëa*," and that until this was done the chain of evidence was not sufficient to compel acceptance, in the full sense that he proposed, of the opinion "that the *Nauplius* stage was the earliest form of the larval condition of prawns;" for, as he remarks in the paper translated in the 'Annals' for last month, his *Nauplius*, having been taken swimming freely in the sea, may not be the larva of *Penæus* at all.

In the important advance which the study of the Crustacea has of late taken, it is highly necessary that statements that are to be accepted as facts should be established on observations that can leave us no doubt.

Unfortunately, on our coasts there is but one species of *Penæus* (*P. caramote*), and this appears to be rather a Mediterranean form that occasionally strays as far as our southern shores than a local species.

We might have supposed, as in the warmer seas several species are abundant, that some one would have been able during these last fifteen years to capture a specimen that was carrying ova so nearly approaching the period of hatching that Fritz Müller's conclusions might have been demonstrated: he would then not have had occasion to say, "if my *Nauplius* be not derived from a *Penæus*, and is not to become a *Penæus*, let my opponents tell me what possibly it can be."

Certainly exception should be taken to the word "opponent;" the only object that any truly sincere observer can have is to establish the truth. If the *Nauplius* form be that of a young of *Penæus* or any other prawn, it is only a question of time for us to know the fact. As yet the young of *Penæus* is not known; and Fritz Müller says that they who wish it demonstrated should tell him what his *Nauplius* is the young of. This can only be done when the larval forms of all prawns, including *Penæus*, are known by direct evidence. We shall therefore be approximating to the knowledge of this by showing what forms do not quit the ovum as larvæ in the *Nauplius* condition.

Some few years since, Dr. Power was attached to a regiment stationed in the Mauritius. During his period of residence in that island he occupied himself with collecting the various forms of Crustacea, and hatched many. These specimens he preserved, both adults and larvæ, and forwarded them to me. It formed the basis of a paper to the Royal Society, a short abstract of which appeared in the 'Proceedings' (No. 168, March 9th, 1876, p. 375*). Of the Macrurous forms we can say with confidence that neither the young of *Palæmon*, of which there is a freshwater species on the Island of Mauritius, as well as our European form, nor *Hippolyte*, *Caradina*, *Crangon*, *Alphæus*, *Homaralphæus*, n. g., *Homarus*, *Stenopus*, *Hymenocera*, *Palinurus*, *Squilla*, nor *Astacus* quits the ovum in the *Nauplius* condition. To these I can now add some of the deep-sea forms, including *Willemoësia*, that were taken during the 'Challenger' expedition. But this still leaves the ques-

* A year previous to the publication of Prof. Claus's memoir 'Untersuchungen zur Erforschung der genealogischen Grundlage des Crustaceen-Systems.'

tion unanswered, What can be the parent of Fritz Müller's *Nauplius*?

Why may it not be the larva of a Schizopod or of one of the parasitic Suctoria? The history of the development of neither of these has been worked out.

Metschnikoff states that *Euphausia* belongs to those Podophthalma that pass through a *Nauplius* condition. He says (Zeitschr. f. wissensch. Zoologie, vol. xix. p. 479), "that this Schizopod, in one stage of metamorphosis, has two pairs of swimming-feet, a peculiar carapace characteristic of *Euphausia*, and only the rudiments of the oral appendages and pleon. Although I knew but this single stage in the development of *Euphausia*, I was yet convinced that it by no means represented the earliest form of larva as it quits the ovum. I could, however, only hypothetically point to a six-legged transparent *Nauplius* as being the earlier larval condition of *Euphausia*."

This supposition he confirmed in a paper in the same journal in 1871, where he stated "that the year previously, being at Villafranca, he had the opportunity of examining a considerable number of freely-swimming *Euphausia*-larvæ;" and he further adds, "besides the larvæ which were in various stages, I fished up with Müller's net ova from which the larvæ were just ready to escape." The statement that he caught the *Nauplii* as free-swimming animals, and captured the ova with a net, raises a question in the mind yet as to the relation of the ova and freely-swimming *Nauplius* with their parent. But as I presume that *Euphausia* must have been present or Metschnikoff would not so positively have asserted their connexion, and as we are not aware of any Crustacea that deposit their ova until they have liberated the larvæ, we must suppose that in taking the one he captured the other. The ova of the Schizopoda being carried in a sac-like pouch and not attached to the pleopoda, as in the prawns, larvæ might be liberated in unequal degrees of development—although he says that, when the larvæ pass into an older stage, "all the larvæ of this last stage examined by me have lost with their moulting the indented margin to the carapace, which shows that I had to do with another species than *Euphausia Mülleri* (Claus)."

As far as the observations of all carcinologists enable us to decide, the form of larvæ, within generic relationship of their parents, is identical in all species. It may be fairly assumed that Claus's specimens, which were captured independently in the Atlantic, may be the young of some other nearly related Schizopod.

That *Euphausia* and its allies may pass through an immature stage like *Nauplius* is what might, though not generally anticipated, have been thought probable since our knowledge of the development of *Mysis*.

The desirability of our knowing the form, structure, progressive growth, and parentage of these young forms is clearly demonstrated in Claus's recent beautiful work on the Genealogical Foundation of the Crustacean System, p. 54, in which he says, "In relation to the transformation of *Galathea*, which, on account of the half-bent tail, was placed with the Anomura, but, however, belongs decidedly to the long-tailed crawfish, unfortunately but little hitherto has become known to us. Couch has given an illustration, which has been reproduced by Bell, of a young recently hatched *Galathea*-larva, which confirmed the observation previously made by Rathke (Archiv f. Nat. 1848, p. 241), that it, as well as the larva of *Pagurus*, represents a higher degree of development than does the *Zoëa* of *Carcinus mœnas*, since, besides the two anterior double-branched pairs of legs, there is also a third jaw-foot present in the form of a still simple numerously jointed appendage—in contrast to the crab-*Zoëa*, which, as far as known in all groups and families of the Brachyura, want the posterior jaw-foot as an acting limb. There appears consequently the character of the prawn-*Zoëa* in the *Galathea*-larva, though in a weakened form, which, taken altogether, according to bodily structure, formation of antennæ, and jaws, might be placed among the long-tailed crawfish."

I do not know Rathke's figure of *Galathea* alluded to by Claus; but if it be not more clearly determined than the one referred to of Couch, it cannot be relied on for guidance as to the form of the animal, and is therefore valueless for general classification.

I have examined, and have in my possession, the young of both British and exotic *Galatheæ*, taken from the parent immediately after being hatched, which show that the larva of *Galathea* in its stage of development resembles *Porcellana* and *Pagurus* in having conditions which, as far as my own observation goes, are common to the Anomurous group. In development they are in advance of the *Zoëæ* of the Brachyura, but not so far as those of the Macrura. The *Zoëæ* of *Latreillia*, *Homola*, *Doripe*, and even *Dromia* have not been determined. I include *Dromia* among the undetermined forms; for the figure that Claus has given with a query as the young of *Dromia* approaches, according to my experience, nearer to the larva of *Gelasimus* than to any of the Anomurous group, while the larva of *Trichia*, a genus nearly allied to *Dromia*, assimilates to the Anomuran stage.

It appears scarcely desirable that any classification of a general character should be attempted upon larvæ that have been so imperfectly made known as that of *Galathea.* And, further, it appears to me that we have the forms of many types yet to determine before we dare hope to establish any permanent classification based on our knowledge of development.

Even so small a generalization as that which Claus has made, that the development of the cephalon and the pleon, with their respective appendages, anticipates that of the pereion with its limbs, is upset in the development of the common lobster, where the pereion and all the pereiopoda are well formed before a single appendage belonging to the pleon is seen. This is shown in the figure of the larva of *Homarus* which accompanied my paper read at the Royal Society in March 1876, as well as by the researches of Erdl, 1843, and the excellent memoir and illustrations of Mr. Sydney F. Smith on the American lobster (*Homarus americanus*, Edw.), 1872, Amer. Journ. Sci.

To return to the *Nauplius*, Fritz Müller says, "The child must surely have a father." True; but let it be the legitimate one. The young of *Penæus* is not known. It appears to me rather remarkable that, among the numerous specimens of several species that have been brought home in the 'Challenger,' I have not been able to find one with ova attached.

There are conditions in some of the Peneids which show a variation in the structure of the reproductive apparatus from that of the more-known prawns that is suggestive of different habits; and I stoutly maintain that it is the duty of every embryologist, and of Fritz Müller in particular, to determine the larva of *Penæus* before we can assert that the young of this genus or any of the prawn-groups can be said to be known to pass through a *Nauplius*-form.

Fritz Müller says that it cannot be the young of a Cirripede or rhizocephalous Crustacean. He bases this opinion on the formation of the heart, liver, and mandibles. All observation strongly supports the conclusion, arrived at long since by Milne-Edwards, that the structural detail of animals in their earliest stages corresponds more with their order than in their generic features. What do we know of the development of the Rhizocephala? What do we know of the development of *Sacculina*, *Cleistosoma*, *Peltogaster*, or any of the parasitic Suctoria? or as to what changes these undergo after the *Nauplius*-stage before they attach themselves as parasites to other Crustacea?

Dr. Power has shown us that in one of these (*Carcino-*

cystus *) the larva undergoes a metamorphosis as far as the cirripede pupa-stage before it is expelled from the ovisac of the parent; and this probably (either in the ovisac or after it has been liberated from it) is a stage in the progressive development of all the Suctorian tribe.

Metschnikoff says, in the paper already alluded to, "In conclusion, I must draw attention to a phenomenon which is common to the *Nauplius*-stage of *Euphausia* and *Penœus*; I mean the contemporaneous formation of several extremities succeeding the larval swimming-feet. It is remarkable that such a mode of formation is not observed in any Entomostraca which have been developed through a *Nauplius*-metamorphosis. I have examined in this relation the Cirripedes and Branchiopoda; and I became convinced that in these Crustacea the oral appendages are developed apart from the other extremities, as has been shown by Claus for the Copepodes."

If the oral appendages be not developed in direct sequence with the anterior appendages of the head, the evidence that the third pair of appendages in the *Nauplius* is the homologue of the adult mandible becomes vitiated.

Darwin has stated (p. 18, vol. i. 'Monograph of the Cirripedia') that the cirripede in the pupa stage has no mouth. "It may be called," he says, "a *locomotive pupa*; its whole organization is apparently adapted for the one great end of finding a proper site for its attachment and final metamorphosis." But Mr. Darwin, "underneath this slightly prominent and closed mouth, found all the masticatory organs of a cirripede in an immature condition." Later, when the animal arrives at its adult stage, it is furnished with oral appendages and uses them in eating.

If we compare the adult Cirripede with the adult Suctorian, the former, though attached to a foreign substance, has all the appendages of an animal in active existence. The latter is scarcely more than a sac, retaining its life apparently through its parasitic union with another. Its only capability appears to be the retention of a number of ova until they become matured. It has no appendage, oral or otherwise. The history of the development of this animal is unknown to us. Of what form is the male? and when does the female become impregnated? Is it before or after it has become attached to another animal? If after, the male must be a free-swimming animal; if before, then we must assume that there is some variation in its pupal condition from that of the normal cirri-

* Proc. Roy. Soc. vol. xxiv. p. 378.

pede; and in this I am inclined to believe. Dr. Power in his drawing has figured the pupa of *Carcinocystus* so that it appears to have a long proboscidiform mouth that is capable of being extended beyond the margin of the walls of the carapace, and so, we may presume, enabling it to feed; and it is difficult to imagine that an animal can grow to so large a size as this is in its adult condition if it had not the existence of an animal, both in feeding and selection, after it had passed beyond the *Nauplius*-condition.

Metschnikoff appears to me altogether to beg the question when he asserts that *Nauplius* is the larval form of *Penæus*, because it resembles that of *Euphausia* in certain conditions of development. After fully considering the subject, it appears to me that Fritz Müller's *Nauplius* may be the larval condition of a Schizopod, more or less related to *Euphausia*, or it may be the young of one of the Suctorian parasites, but that there is every reason to believe that it is not the young of any known prawn, and there is no evidence to determine its relation to *Penæus*.

X.—*On* Stromatopora.

By H. J. Carter, F.R.S. &c.

In my last paper ('Annals,' 1878, vol. i. p. 412) it is stated that the "hexactinellid structure," therein mentioned, "if not a sponge was still not a *Stromatopora*;" and further on, "at least" not of "the type to which I allude."

I am now able to solve the difficulty by having a short time since, through specimens of Babbicombe (Devonian) Limestone brought to this place (Budleigh-Salterton) for calcination, found that the "hexactinellid structure" is presented by *Stromatopora concentrica*, and just now, by the kind aid of Mr. Vicary, together with his books and specimens, have also been able to determine that the latter is *Caunopora*, Phill., 1841, = *Stromatopora placenta*, Lonsdale ap. Baily (see most satisfactory representations of both species in Phillips's 'Palæozoic Fossils of Cornwall, Devon, and West Somerset,' 1841, pl. x. figs. 21, 29).

These two points have been verified by an inspection of Mr. Vicary's great collection of *Stromatoporæ* to which I have before alluded, whereby it seems to me that, to expose the hexactinellid figure, the plane of section must be tangential to the curve of undulation in the layers of the *Stromatopora*, or horizontal to its summit—also that the more abrupt the undulation the more limited will be its extent, and *vice versâ*; yet this structure does not always present the same figure.

The *natural surface* of *Stromatopora concentrica* from the Devonian Limestone is represented in fig. 19, and that from the Silurian formation (which Mr. Sollas lent me) in fig. 24 ('Annals,' 1877, vol. xix. pl. viii.), where the pores (? calicles) are not only larger, but, to the best of my remembrance, the main structure of the corallum in the Silurian specimen was like that of *Caunopora*, that is, like that of *Millepora alcicornis*. The natural *surface* of *Caunopora* is represented in fig. 20, pl. viii. (*l. c.*).

It must not, however, be inferred, because I have considered this hexactinellid structure "identical in appearance" with that of Zittel's suborder Dictyonina ('Annals,' 1877, vol. xx. p. 416), that *elementarily* it is so; for in this consists the difference between the hexactinellid structure of *Stromatopora concentrica* and its varieties and that of the vitreous sponges with *octahedral elements* ('Annals,' 1877, vol. xix. pl. ix. figs. 11, 12).

The pores (? calicles) are in the interstices of the hexactinellid structure; but I cannot say more about them than that, by their minuteness in *S. concentrica*, they appear to have belonged to a Hydroid, rather than to an Actinozoic polyp.

XI.—*Descriptions of three Species of* Doryphora *from Peru and the Amazons.* By J. S. Baly, F.L.S.

Doryphora modesta.

D. rotundato-ovata, valde convexa, pallide picea, subtus nitida, supra subopaca, antennis fulvis, capite thoraceque pallide castaneis, minute punctatis, facie inter oculos flava; elytris tenuissime punctato-striatis, striis confuse gemellatis, sordide fulvis, olivaceo tinctis, margine basali, limbo inflexo lineisque suturali et laterali angustis (his pone medium fere deletis) piceis.

Long. $5\frac{1}{2}$ lin.

Hab. Amazons, Santarem.

Face between the eyes broad, plane, minutely granulose, sparingly impressed with fine punctures; median space with a slender, very slightly raised, longitudinal line; jaws coarsely punctured; antennæ longer than the head and thorax, pale fulvous. Thorax nearly three times as broad as long; sides nearly straight and slightly converging from the base to beyond the middle, rounded in front, the anterior angles mucronate; upper surface slightly excavated on either side, minutely but not closely punctured, the interspaces finely granulose. Scutellum nitidous, obscure fulvous, narrowly edged with piceous. Elytra broader than the thorax, very minutely punctured, the punctures irregularly arranged in double longitudinal rows; interspaces finely granulose, obscure fulvous, the basal margin, together with the anterior halves of the lateral and sutural limbs, narrowly edged with piceous.

Doryphora Waterhousei.

D. oblongo-ovata, convexa, læte cuprea, nitida, subtus obscure viridi-cuprea aut ænea, pedibus antennisque viridi-metallicis, his extrorsum nigris; thorace parce tenuiter punctato, lateribus latis, leviter incrassatis; elytris tenuiter punctato-striatis, striis geminatis, ad latus magis confusis.

Long. $6\frac{1}{2}$ lin.

Hab. Amazons, Santarem.

Lower face impressed with an elongate fovea, on either side of which are several irregular punctures; antennæ less than half the length of the body, five lower joints bright metallic green, the six outer ones black. Thorax as broad as the elytra; sides rounded, converging in front, the anterior angles acute, submucronate; disk finely but sparingly punctured, lateral margin broad, distinctly thickened, bounded within by a longitudinal sulcation. Scutellum trigonate. Elytra finely punctate-striate, the striæ gemellate, the punctures much less regularly placed in the striæ on the outer disk.

Doryphora Chapuisi.

D. late ovata, convexa, cæruleo-metallica, subtus nitida, supra subopaca, thorace fere duplo latiore qaum longiore, lateribus parallelis, ad apicem rotundato-angustatis, angulis anticis mucronatis; disco fere impunctato; elytris thorace latioribus, tenuissime punctato-striatis, interspatiis punctis minutis sparse impressis; mesostethio acuto, metasterno vix longiore.

Long. 6 lin.

Hab. Peru.

Broader than *D. prasina*, Erichs., much more finely punctured. Antennæ four fifths the length of the body; five lower joints nitidous, tinged with metallic green, the six upper ones opaque, obscure cæruleous.

XII.—*On the Structure of* Haliphysema Tumanowiczii. By E. Parfitt.

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

Gentlemen,

In the April number of the 'Annals' the Rev. A. M. Norman has drawn attention to that much-abused and much-written-about little sponge *Haliphysema Tumanowiczii*, Bowerbank. Although this little organism has been scrutinized so much, there are certain points of interest in its structure that appear to have been overlooked. I was the first to draw attention to the peculiar structure of the base of the test, showing that the base was divided by septa, and that the septa radiated after the manner of the spokes of a wheel. This I published in the 'Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art,' in 1868, in the continuation of my "Fauna of Devon," section Spongiadæ. Copies of this section I forwarded to several naturalists who I knew took an interest in the study of sponges, viz. our late friend Dr. Bowerbank, Mr. Carter, the Rev. A. M. Norman, &c.

The Rev. A. M. Norman says, in his article above referred to (p. 267), "Next Mr. Carter entered into a minute description of the chambered character of the discoidal base, thus confirming Mr. Parfitt's observations, of which, however, he does not seem to have been aware."

But Mr. Carter had my paper in his hands, and might, I think, have credited me with this little discovery. The structure is so remarkable, and, I believe, so far is unique in the structure of the Spongiadæ. Had it not been for the Rev. A. M. Norman's very clear and excellent paper, with the chronological arrangement of the various articles that have been written on this *Haliphysema*, I should not have observed that I had been so soon lost sight of.

Before the departure of the Rev. A. M. Norman for Norway I wrote him to this effect, that all had not been discovered yet in the structure of this little sponge, at the same time giving him rough sketches of the discoveries. But before I proceed to describe what I have observed, it may be as well to state that, although in a great many specimens the septa are radiated, some from a circular ring placed in the centre of the base of the test, from which from four to eight radii diverge and meet the periphery, or the reverse of this, they either grow or are rather built up from the periphery towards the centre; this remains to be seen. Be this as it may, the radii are sometimes enlarged at one end and sometimes at the other;

and there are other specimens in close proximity to these that have the septa anastomosed, so that they do not radiate directly across from centre to periphery, or from the central ring before noticed, but they become divided into irregular compartments, somewhat after the manner of Mr. Carter's fig. 7, pl. 4, 'Annals,' 1870 (vol. v. 4th series). In many specimens the radii join a central ring, which ring would appear at first, and without examining a number of specimens, to be the base of the pedicel; but this is not the case, as the pedicel does not go below the top of the dome-shaped test. The radii, whether straight or irregular, rise from the base to the top of the inside of the dome, and converge round the orifice which opens into the pedicel.

When the pedicel has been carefully removed from the top, there will be seen a smooth, white, calcareous-looking ring; it has the appearance of a flat collar having been let into the top of the dome. This, so far as I am aware, has not been noticed before. In all the specimens of *Haliphysema Tumanowiczii* that I have seen there is a rather deep depression in the top of the dome-shaped test, in the centre of which the white ring before mentioned is placed; and on this ring is the base of the pedicel. Taking, then, into consideration this white smooth ring, it being composed of finer materials than the rest of the test and of the depression in the centre of which the pedicel is placed, I cannot help thinking that there are provisions for a lateral movement of the pedicel when the organism is alive.

If this is a true interpretation of the uses to which these peculiarities of structure are applied, I think we may claim for this little sponge something more that is unique in this group of organisms.

When Dr. Bowerbank examined and described this species of *Haliphysema* he was not able to detect the "pores;" and, so far as I am aware, no observer has seen or described them up to this time.

On a recent examination of my specimens under peculiarly good circumstances as regards light and definition, I was enabled to discover them. When the test is examined under the above conditions it is seen to be composed of chitinous fibres, some running parallel and others interlacing each other. It is in the interstices of these fibres that I discovered the pores, each pore being surrounded with minute grains of sand. So far as I could see, the pores do not penetrate the entire wall of the test, but only the epidermis or outer layer of the chitinous fibres; they are then lost in the substance of the wall of the test.

I hope these notes may prove interesting to those devoted to this branch of study, and that all that I have stated will soon be verified by other observers.

I am, Gentlemen,
Yours obediently,
Exeter, May 10, 1878. EDWARD PARFITT.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

May 9th, 1877.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communications were read :—

1. "On the Agassizian Genera *Amblypterus*, *Palæoniscus*, *Gyrolepis*, and *Pygopterus*." By Ramsay H. Traquair, Esq., M.D., F.R.S.E., F.G.S.

The author's object in this paper was to discuss the characters by which the above genera of fossil fishes have been supposed to be distinguished in the case of specimens from the Carboniferous series. In *Amblypterus* he distinguished five types among the species referred to that genus by Agassiz, viz. :—I. Of *A. latus*; II. Of *A. macropterus* = genus *Rhabdolepis*, Trosch.; III. Of *A. striatus* = *Cosmoptychius*, g. n.; IV. Of *A. nemopterus* = genus *Elonichthys*, Gieb.; V. Of *A. punctatus* = *Gonatodus*, g. n. In *Palæoniscus* he distinguished the following types :—I. Of *P. Freieslebeni*; II. Of *P. Duvernoyi* = genus *Amblypterus*, Ag.; III. Of *P. striolatus* = genus *Elonichthys*, Gieb.; of *P. ornatissimus* = *Rhadinichthys*, g. n.; VI. Of *P. glaphyrus* = *Acentrophorus*, g. n.; VII. Of *P. catopterus* = genus *Dictyopyge*, Egert. He further discussed at great length the characters and affinities of the genera *Gyrolepis* and *Pygopterus*, the former of which he regarded as untenable, on the ground of its being founded on fragmentary remains of fishes belonging to several other genera; and the latter as divisible into the following groups :—I. Type of *P. Humboldtii*, Permian only; II. Type of *P. Bucklandi* = *Elonichthys*, Gieb.; III. Type of *P. Greenockii* = *Nematoptychius*, g. n. There are no Carboniferous species of *Pygopterus* proper.

2. "On the Circinate Vernation, Fructification, and Varieties of *Sphenopteris affinis*, and on *Staphylopteris* ? *Peachii*, Etheridge and Balfour, a Genus of Plants new to British Rocks." By C. W. Peach, Esq., A.L.S.

The author noticed the occurrence in the Carboniferous shales near West Calder (Edinburgh) of abundant remains of the fern described by Lindley and Hutton as *Sphenopteris affinis*, dwelling especially on the circinate vernation and supposed fructification of the plant. With it were found many fragments of small flower-like parts, which had been referred to the genus *Staphylopteris*, Presl, the fructification especially resembling that ascribed to that genus. The author considered that in all probability the *Staphylopteris* was parasitic upon the *Sphenopteris*, perhaps after the fashion of *Cuscuta* upon flowering plants.

3. "On the Occurrence of a Macrurous Decapod (*Anthrapalæmon Woodwardi*, sp. nov.) in the Red Sandstone, or Lowest Group of the Carboniferous Formation in the South-East of Scotland." By Robert Etheridge, Esq., jun., F.G.S.

After giving a detailed bibliography of the Palæozoic Malacostracous Crustacea, the author described the remains of a small Crustacean from the lower group of the Carboniferous formation near Dunbar, and discussed its affinities and systematic position, which he regarded as being among the Macrurous Decapods, although the absence of the eyes in the preserved specimens, and some other characters, rendered it doubtful whether it might not in some respects approach the Stomapoda. Its position among the Macrura seemed, however, to be established by the well-developed abdominal somites and telson. He referred the fossil to Salter's genus *Anthrapalæmon*, and named the species *A. Woodwardi*.

4. "On the Stratigraphical Position of the Corals of the Lias of the Midland and Western Counties of England and of South Wales." By R. F. Tomes, Esq.

The object of this paper was to give the precise stratigraphical position of the species of Liassic Corals collected by the author and his friends in the districts above mentioned. He noticed 41 species, of which 15 were described as new, namely:—*Cyclolites Anningi*, *Thecosmilia longiserialis*, *Montlivaltia cyclolites*, *Thamnastræa Etheridgii*, *Thecocyathus mucronata*, *Montlivaltia papyracea*, and several others to which no specific names are attached, chiefly belonging to the genus *Isastræa*.

May 23rd, 1877.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communication was read:—

2. "On the Structure and Affinities of the Genus *Siphonia*." By W. J. Sollas, Esq., B.A., F.G.S.

This paper contained, first, a full account of the history of the genus *Siphonia*, including a complete list of its described species, and, next, a description of its general and minute structure. Its skeletal network was shown to consist of spicular elements belonging to the Lithistid type of sponges, and most closely allied in generic details to the recent form *Discodermia polydiscus*. Not only in this character but in every other, *Siphonia* was shown to approach *Discodermia* so closely as to be almost identical with it.

The mineral replacements which have affected the siliceous skeleton of *Siphonia* were then considered: in specimens preserved in phosphate of lime from the Gault of Folkestone the spicules have undergone a replacement by calcic carbonate, while those from the greensand of Haldon and other localities still possess a siliceous composition though the interior of the spicules has been dissolved away so as to enlarge the axial quadriradiate canal to a surprising extent; and the silica so dissolved has been re-deposited on the exterior of the spicule, so as to fill up the interstices of the network, and in some cases the cavities of the canal-system of the sponge. Thus, to some slight extent, these specimens may be said to have fossilized themselves.

Choanites was shown to be the deep-sea form of *Siphonia*, the latter characterizing Greensand deposits which were laid down in depths corresponding to those in which existing Lithistids now flourish, while the former is characteristic of the Chalk which was deposited in a deeper sea.

The paper concluded with a systematic description of the genus.

June 6th, 1877.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communications were read:—

1. "On the Rank and Affinities in the Reptilian Class of the *Mosasauridæ*, Gervais." By Prof. R. Owen, C.B., F.R.S., F.G.S.

The author stated that while the Mosasaurians had been originally referred to the Cetacea by Camper, then to Crocodilia by Faujas de St. Fond, and to the Lacertilia by Cuvier, Prof. Cope had recently thought he recognized in them Ophidian affinities, spoken of them as "sea-serpents," and formed of them an order called Pythonomorpha. He then discussed in detail the various characters presented by the remains of these animals, and arrived at the following conclusions:—In the single occipital condyle and the composite structure of the mandible the Mosasaurians are Reptilian, as also in their procœlian vertebræ; in the double occipital hypapophyses, the bifurcate and perforate parietal, the presence of the "columella," the composite formation of the suspensory joint of the tympanic and in the type of the tympanic, the frame of the parial nostrils, and the structure and attachment of the teeth they are Lacertian. In one special dental modification they are Iguanian, in another Monitorial; and their special group characters consist in the more extensive fixation of the pterygoids and ossification of the roof of the mouth, the large proportion of the vertebral column devoid of zygapophyses, the confluence of the hæmal arch with the centrum in certain of the caudal vertebræ, and the natatory character of the fore and hind limbs. These distinctive characters did not appear to the author to be sufficient for ordinal rank, and with P. Gervais he regarded the

Mosasauridæ as a family of Lacertilia equivalent to the Iguanodontidæ and Megalosauridæ in the order Dinosauria. The order Lacertilia among Reptiles, being equivalent to the order Carnivora or Feræ among Mammals, the Mosasaurians would be the equivalents of the Seals in the latter.

2. "Note on the Occurrence of the Remains of *Hyænarctos* in the Red Crag of Suffolk." By Prof. William Henry Flower, F.R.S., F.G.S.

The traces of *Hyænarctos* described by the author in this paper consist of a right and a left first upper molar, which were obtained from the Red Crag of Waldringfield, and are so much alike, that but for the former being rather more worn they might have belonged to the same animal. On comparison these teeth were found to show no appreciable difference from the corresponding teeth of the original specimen of *Hyænarctos sivalensis* from the Sewalik Hills, and hence the author did not venture to regard them as representing a species distinct from the Indian one. The author discussed the synonymy of this species, which was first described by Falconer and Cautley, in 1836, under the name of *Ursus sivalensis*. The genus *Agriotherium* was established for it by Wagner in 1837, and the names *Amphiarctos* and *Sivalarctos* were given to the genus by Blainville in 1841; but Falconer and Cautley's name *Hyænarctos*, although certainly of later date, has been generally adopted. Remains of the genus have been found in the Pliocene marine sands of Montpellier (*H. insignis*, Gerv.), and in Miocene beds at Sansans (*H. hemicyon*) and at Alcoy, in Spain. A nearly perfect mandible of *H. sivalensis* has recently been obtained in its original locality by Mr. Theobald.

3. "On the Remains of *Hypsodon*, *Portheus*, and *Ichthyodectes* from British Cretaceous Strata, with Descriptions of new Species." By E. Tulley Newton, Esq., F.G.S., of H.M. Geological Survey.

Hypsodon lewesiensis, as established by Agassiz in the "Poissons Fossiles," it appears includes two forms which are generically distinct, and the author felt justified in adopting Prof. Cope's suggestion for their separation. It is proposed to retain the above name for the specimen upon which the genus and species was really founded, and to refer to the genus *Portheus*, Cope, the upper jaw, with large irregular teeth, which had already been described by Dr. Mantell in 1822 as "an unknown fish." To this the specific name of *P. Mantellii* is to be given. Another maxillary bone from the Lower Chalk, characterized by its greater proportionate depth and the convexity of its dentary border, as well as by the more equal size of its teeth, it is proposed to name *P. Daviesii*.

A very fine specimen from the Gault belonging to this same genus was described in detail. This fish is closely allied to *P. lestris*, Cope, but differs in the form of its maxilla and premaxilla, and is chiefly remarkable for the peculiar incurving of the points of the mandibular teeth. The parts of this specimen which are preserved are—both upper and lower jaws, parts of the palato-quadrate arch, of the hyoid bones, ethmoidal region, brain-case, &c. *Portheus gaultinus* is the name suggested for this species.

Hypsodon minor, Egerton, figured in Dixon's 'Fossils of Sussex,' will now, it is thought, on account of the regularity of its teeth, have to be placed in the genus *Ichthyodectes*, Cope.

Another small mandible from the Lower Chalk of Dorking, which is distinguished by the regularity of its slender, incurved, and oblique teeth, it is proposed to call *Ichthyodectes elegans.*

June 20th, 1877.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communications were read:—

6. "On the Cretaceous Dentaliadæ." By J. S. Gardner, Esq., F.G.S.

In this paper the author described the Dentaliadæ from the British Cretaceous rocks, of which he enumerated the following species:—*Dentalium decussatum*, Sow., and var. *ellipticum*, Sow. (Gault); *D. medium*, Sow. (Gault, Greensand, and Grey Chalk); *D. divisiensis*, sp. n. (Upper Greensand); *D. alatum*, sp. n. (Gault); *D. cylindricum*, Sow. (Blackdown); *D. acuminatum*, sp. n. (Gault); *D. subtetragonum*, sp. n. (Gault); *D. tetragonum*, sp. n. (Gault); *Entalis Meyeri*, sp. n. (Blackdown); and *Gadus gaultinus*, sp. n. (Gault).

10. "The Exploration of the Ossiferous Deposit at Windy Knoll, Castleton, Derbyshire, by Rooke Pennington, Esq., LL.B., F.G.S., and Prof. W. Boyd Dawkins." By Prof. W. Boyd Dawkins, M.A., F.R.S., F.G.S.

In this paper the author gave an account of the results of a further exploration of the ossiferous deposit at Windy Knoll. The section exposed included the following beds in descending order:—Clayey débris without bones, probably quarry rubbish; yellow clay, with large blocks of limestone, &c., and containing bones of Bison, Reindeer, Hare, Wolf, Fox, and Bear; and stiff yellow loam resting on the surface of the limestone. The bones and teeth of animals were generally perfect, and had been buried in their natural positions. The entire skeleton of a Roedeer was found in the upper part of the yellow clay. As the work proceeded the limestone floor descended rapidly, and the ossiferous clay increased in thickness from 8 to 21 feet; at the bottom it rested on loose fragments of limestone, filling a vertical shaft. The author concluded that the rock basin containing the ossiferous deposit was originally a swallow-hole, plenty of which occur in the immediate neighbourhood, and that the vertical shaft, filled with limestone fragments, probably led down into a cavern through which drainage took place. The rock-basin forming the mouth of the swallow-hole was lined with clay, as is not uncommon, and then converted into a pool, in which the ossiferous clay was accumulated. The author noticed the geographical changes which must have occurred in the district since the formation of the deposit, and indicated the proportions of the remains of young and old Bisons and Reindeer, which confirmed the conclusion arrived at in his former paper, that the Bisons were here in the summer and the Reindeer in the winter. He regarded the deposit as of late Pleistocene age.

11. "Description of the Fossil Organic Remains from Bendigo." By M. Carl August Zachariæ.

In this paper the author described the fossils obtained by him from the slate deposits in the neighbourhood of the auriferous quartz reefs of Bendigo. He remarked on the absence of Trilobites and of Diplograptian Graptolites; *Lingula* is of very rare occurrence, Monoprionidian Graptolites abound, bivalved Phyllopods are frequent, and there are doubtful examples of a Stomapod Crustacean. This last is described but not named. The Phyllopod is described as forming a new genus named *Alaocaris*. The *Lingula* is identified with *L. Davisii*. Some species of *Sertularia* are described as new under the names of *S. australis*, *S. astricus*, *S. truncus lapillarum*, *S. magna*, and *S. virgata*. Of Graptolites the author notices the occurrence of gonothecæ (?), and of the following species:—*Graptolites Sedgwickii*, *Graptolithus* (*Didymogapsus*) *planus*, sp. n., *G. extensus*, *geminus*, *serratulus*, *tripedes*, sp. n., *tetrapleurus*, sp. n., *Murchisoni*, *fruticosus*, *pygmæus*, sp. n., *campanula*, sp. n., *crassus*, sp. n., *bryonoïdes*, *scopula*, sp. n., *spinifer*, sp. n., *quadribrachiatus* and var. *gracilis*, *octobrachiatus*, *Mackayi*, sp. n., *Hutchinsoni*, sp. n., *roseta*, sp. n., *briareus*, sp. n., *filicatus*, sp. n., *Pythagoras*, sp. n., *cardunus*, sp. n., *stellatus*, sp. n., and *trifarium*, sp. n., and *Phyllograptus folium*.

November 7th, 1877.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communications were read:—

2. "Notes on Fossil Plants discovered in Grinnell Land by Capt. H. W. Feilden, Naturalist to the English North-Polar Expedition." By Prof. Oswald Heer, F.M.G.S.

Near Discovery Harbour, where H.M.S. "Discovery" wintered in 1875–6, in about 81° 45′ N. lat., and 64° 45′ W. long., a bed of lignite, from 25 to 30 feet thick, was found, resting unconformably upon the azoic schists of which Grinnell Land chiefly consists. The lignite was overlain by black shales and sandstones, the former containing many remains of plants; and above these there were, here and there, beds of fine mud and glacial drift, containing shells of marine Mollusca of species now living in the adjacent sea. This glacial marine deposit occurs up to levels of 1000 feet, indicating a depression and subsequent elevation of the region to at least this extent.

Remains of 25 species of plants were collected by Capt. Feilden, and 18 of these are known from Miocene deposits of the Arctic zone. The deposit is therefore no doubt Miocene. It has 17 species in common with Spitzbergen (78° 79′ N. lat.), and 8 species in common with Greenland (70° 71′ N. lat.). With the Miocene flora of Europe it has 6 species in common; with that of America (Alaska and Canada) 4; with that of Asia (Saghalien) 4 also. The species found include 2 species of *Equisetum*, 10 Coniferæ, *Phragmites œningensis*, *Carex noursoakensis*, and 8 Dicotyledons, namely, *Populus arctica*, *Betula prisca* and *Brongniarti*, *Corylus Macquarrii* and *insignis*, *Ulmus borealis*, *Viburnum Nordenskiöldi*, and *Nymphæa arctica*.

Of the Conifers, *Torellia rigida*, previously known only by a few fragments from Spitzbergen, is very abundant, and its remains show it to have been allied to the Jurassic genera *Phœnicopsis* and *Baiera*, the former in its turn related to the Carboniferous *Cordaites*, and, among recent Conifers, to *Podocarpus*. Other Conifers are, *Thuites Ehrenswärdi* ?, *Taxodium distichum miocenum* (with male flowers), *Pinus Feildeniana* (a new species allied to *P. strobus*), *Pinus polaris*, *P. abies* (twigs covered with leaves), a species of *Tsuga* (*Pinus Dicksoniana*, Heer), and a white Spruce of the group of *Pinus grandis* and *cariocarpa*. *Pinus abies*, which occurs here and in Spitzbergen, did not exist in Europe in Miocene times, but had its original home in the extreme north, and thence extended southwards; it is met with in the Norfolk forest-bed, and in the interglacial lignites of Switzerland. Its present northern limit is 69½° N., and it spreads over 25° of latitude. *Taxodium distichum*, on the contrary, spread in Miocene times from Central Italy to 82° N. latitude, whilst at present it is confined to a small area.

Betula Brongniarti, Ett., is the only European species from Grinnell Land not previously known from the arctic zone.

The thick lignite-bed of Grinnell Land indicates a large peat-moss, probably containing a lake in which the water-lilies grew; on its muddy shores stood the large reeds and sedges, the birches, poplars, *Taxodia*, and *Torelliæ*. The drier spots and neighbouring chains of hills were probably occupied by the pines and firs, associated with elms and hazel-bushes. A single elytron of a beetle (*Carabites Feildenianus*) is at present the sole evidence of the existence of animals in this forest-region.

The nature of the flora revealed by Capt. Feilden's discoveries seems to confirm and extend earlier results. It approaches much more closely to that of Spitzbergen than to that of Greenland, as might be expected from the relative positions of the localities; and the difference is the same in kind as that already indicated by Prof. Heer between Spitzbergen and Greenland, and would indicate the same kind of climatic difference. Nevertheless, the presence of *Taxodium distichum* excludes arctic conditions, and that of the water-lily indicates the existence of fresh water, which must have remained open a great part of the year. Representatives of plants now living exclusively in the arctic zone are wanting in the Grinnell-Land deposits; but, on the other hand, most of the genera still extend into that zone, although they range in Grinnell Land from 12° to 15° further north than at present.

3. "On our present Knowledge of the Invertebrate Fauna of the Lower Carboniferous or Calciferous Sandstone Series of the Edinburgh Neighbourhood, especially of that division known as the Wardie Shales, and on the first appearance of certain Species in the Beds." By R. Etheridge, Esq., Jun., F.G.S.

The Calciferous Sandstone series of the district described consists, according to the author, of two divisions:—the superior, or "Cement-stone group," composed of sandstones, shales, oil-shales, some thin coals, and a few limestones; the inferior, or "Red Sandstone," consisting of red and grey sandstones, conglomerates, marls, and cornstones. The latter are very unfossiliferous, an Entomostracan (*Estheria Peachii*) being the only fossil known from the Red Sandstone. In some sandstones and shales at Clubbiedean Reservoir, placed with doubt at the base of the Cement-stone group, *Leperditia scotoburdigalensis* and a crushed bivalve (*Myalina*?) occur with *Sphenopteris affinis*; and a limestone belonging to the same set of beds is almost entirely composed of *Spirorbis helicteres* with *S. carbonarius* (?). In shales at Craiglockhart Hill, *Discina nitida*, *Lingula squamiformis* (?) and *mytiloides*, *Anthracosia nucleus*, *Avicula Hendersoni*, and a new *Myalina* occur. In the Wardie Shales at Woodhall *Serpulites carbonarius*, a species of *Chætetes*, a new species of *Leda*, *Myalina crassa*, var., a species of *Aviculopecten*, *Schizodus Salteri*, *Pandora typica*, *Pleurotomaria monilifera*, *Murchisonia striatula* (?), *Bellerophon decussata*, var., a species of *Conularia*, *Nautilus cariniferus*, and a species of *Orthoceras* make their appearance, associated with several of the previously mentioned fossils. This appears to be the richest deposit in the whole group; but a new species not found in it occurs elsewhere. The author has increased the known invertebrate fauna of the Calciferous Sandstone group in this district from 20 to 30 species, most of which he describes and figures, and among them the following are distinguished as new or undetermined:—*Chætetes*, sp., *Avicula Hendersoni*, *Aviculopecten*, sp., *Anthracoptera obesa*, *Myalina sublamellosa*, *Nuculana Sharmani*, *Pandora*? *typica*, *Littorina*? *scotoburdigalensis*, *Conularia*, sp., and *Orthoceras*, sp.

From his investigation of these species he indicated the occurrence of at least three or four marine beds in the Calciferous Sandstone series in addition to that mentioned by Mr. Salter, namely, at Craiglockhart, at Woodhall, Water of Leith, at Drumsheugh, which may be identical with the last, and probably at Dean Bridge. Several of the species which occur low down in this series, attain their greatest development in, and are characteristic of, the Carboniferous Limestone series.

December 19th, 1877.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communications were read:—

1. "On *Argillornis longipennis*, Owen, a large Bird of Flight, from the Eocene Clay of Sheppey." By Prof. Owen, C.B., F.R.S., F.G.S., &c.

In this paper the author described some remains of a large bird obtained by Mr. W. H. Shrubsole from the London Clay of Sheppey, consisting of parts of fractured humeri belonging to the right and left sides of the same species or perhaps individual, and including the head of the bone, with portions of the upper and lower parts of the shaft. The texture of the shaft, the thinness of its bony wall, and the large size of the cavity recall the characters of the wing-bones of the large Cretaceous Pterodactyles. The author indicated the characters which led him to regard the remains under consideration as those of a volant bird, most nearly approaching the genera *Pelecanus* and *Diomedea*; and as the evidence derived from the cranium of *Dasornis* would indicate a bird too large to be upborne by wings to which these bones might have belonged, whilst the skull of *Odontopteryx* is far too small to have formed part of a bird with wings as large as those of the Albatross, and *Lithornis* and *Pelargornis* are excluded by the characters of their remains, the author concluded that the bones obtained by Mr. Shrubsole furnished indications of a new genus and species of flying birds, for which he proposed the name of *Argillornis longipennis*. He regarded it as probably a long-winged natatorial bird, most nearly related to *Diomedea*, but considerably exceeding the Albatross (*D. exulans*) in size. The author remarked that the generic name *Megalornis*, proposed by Prof. Seeley for the *Lithornis emuianus*, Bowerb., had been preoccupied by the late Mr. G. R. Gray.

2. "Contributions to the History of the Deer of the European Miocene and Pliocene Strata." By Prof. W. Boyd Dawkins, M.A., F.R.S., F.G.S.

The author commenced by referring to the difficulties attending the study of the European Miocene and Pliocene Deer, and indicated that the majority of the known antlers may be referred to two categories—an earlier or Capreoline, and a later or Axidine type. To the Capreoli he referred the following species:—*Dicroceros elegans*, Lart. (=*Prox furcatus*, Hensel), *Cervus dicranoceros*, Kaup (including *C. anoceros* and *trigonoceros*, Kaup), and *Cervus Matheroni*, Gerv. (=*C. Bravardi*), from the Miocene, and *Cervus australis*, Gerv., and *C. cusanus*, Croizet & Jobert, from the Pliocene. To the Axeides belong *Cervus Perrieri*, Cr. & Job. (including *C. issiodorensis* and *pardinensis*, of the same authors), *C. etueriarum*, Cr. & Job. (=*C. rusoides*, Pom., and *C. perollensis* and *stylodus*, Brav.), *C.*

suttonensis, sp. n., and *C. cylindroceros*, Brav. (including *C. gracilis*, Brav.), all from Pliocene deposits. Besides these, the author noticed a species *incertæ sedis* under the name of *Cervus tetraceros*, Dawkins, which he regards as coming nearest to the Virginian Deer, or Cariacou (*Cariacus virginianus*). From the examination of the antlers of these species he indicates that in the Middle Miocene age the cervine antler consisted of a simply forked crown, whilst in the Upper Miocene it becomes more complex, although still small and erect, like that of the Roe Deer. In the Pliocene it becomes larger and more complex, some forms, such as the *Cervus dicranios*, Nesti, being the most complicated of known antlers. The successive changes are analogous to those observed in the development of the antlers of the living Deer with increase of age. In the Miocene we have the zero of antler-development, and the Capreoline type is older than any other. The nearest living analogue of the Miocene Deer is, according to the antler, the Muntjak (*Styloceros*), now found only in the oriental region of Asia, along with the Tapir, which also coexisted with *Cervus dicranoceros* in the Miocene forests of Germany. The Pliocene Deer, again, are generally most nearly allied to the oriental Axis and Rusa Deer, the only exception being *Cervus cusanus*, the antlers of which resemble those of the Roe, an animal widely spread over Europe and Northern and Central Asia. The alliance of these Pliocene Deer with those now living in the Indian region is regarded by the author as a further proof of the warm climate of Europe in Miocene times, confirmatory of the conclusions arrived at by Saporta from the study of the vegetation.

3. "On the Occurrence of *Branchipus* (or *Chirocephalus*) in a Fossil State, associated with *Archæoniscus* and with numerous Insect-remains in the Eocene Freshwater Limestone of Gurnet Bay, Isle of Wight." By Henry Woodward, Esq., F.R.S., F.G.S.

The remains of Crustacea and Insects noticed in this paper were obtained by Mr. E. J. A'Court Smith from a thin bed of limestone belonging to the Osborne or St. Helen's series at Thorness and Gurnet Bay in the Isle of Wight. The collection is the result of about 20 years' work. The insect-remains comprise about fifty specimens of Diptera, including wings of Tipulidæ and Culicidæ, and the pupa apparently of a Gnat, one wing of a Hemipterous insect, and a flattened Homopterous insect identified by Mr. F. Smith with *Triecphora sanguinolenta*; two specimens referred to the Lepidopterous genus *Lithosia*; only three Orthoptera, one a *Gryllotalpa*, the other two belonging to a Grasshopper; thirty-five Hymenopterous wings, thirty-three of which are referred to Ants of the genera *Myrmica*, *Formica*, and *Camponotus*; twenty-three examples of Neuroptera referred to *Termes*, *Perla*, *Libellula*, *Agrion*, *Phryganea*, and *Hemerobius*; and twelve of Coleoptera, including species of *Hydrophilus*, *Dyticus*, *Curculio*, *Anobium*, *Dorcus*, and *Staphylinus*. There were also two Spiders. Several species of bivalved

Entomostraca have also been obtained from these deposits, and identified by Prof. Rupert Jones. Of the Branchipod Crustacean both sexes are fossilized and beautifully preserved, the males showing their large clasping antennæ, and the females their egg-pouches, with large and very distinct disk-like bodies representing the compressed eggs. Dr. F. Goldenberg notices a fossil from the Coal-measures of Saarbrück which he regards as a Branchipod, and describes and figures under the name of *Branchipusites* (rectè *Branchipodites*) *anthracinus*; but this interpretation of it is at least doubtful. The author names his species *Branchipodites vectensis*. The Isopods accompanying this species are referred to the genus *Archæoniscus*, M.-Edw., and one of them is identified with the *Palæoniscus Brongniarti* of Milne-Edwards. The other is probably a new species, perhaps nearly allied to the existing *Sphæroma serratum*.

February 6th, 1878.—Prof. P. Martin Duncan, M.B., F.R.S., President, in the Chair.

The following communications were read:—

1. "On some Foraminifera from Pleistocene Beds in Ischia." By M. Ernest Vanden Broeck. Preceded by some Geological Remarks by A. W. Waters, Esq., F.G.S.

In this note Mr. Waters referred to certain fossiliferous deposits occurring at various elevations in the island of Ischia, the oldest being a clay found up to 1800 feet on Monte Buceto, whilst the others may be classed with raised beaches. These deposits have been already noticed by Sir Charles Lyell, who obtained from them twenty-eight species of shells, all, with one exception, identified by Deshayes with recent species. M. Fonseca has given a list of ten species of shells from the Buceto beds, and to these Mr. Waters has added ten more, all now living in the neighbouring sea. A portion of marl forming the matrix of one of these shells was sent by Mr. Waters to M. Vanden Broeck, who found in it twenty-seven species of Foraminifera, with respect to which he remarks that this fauna has a more recent facies than that of the true Subapennine deposits, all the species being now living either in the North Atlantic or Arctic ocean, and nearly all in the Mediterranean. The presence of *Lagenæ* and of some other forms, however, indicates closer relations with the northern oceanic fauna than with that of the warmer Mediterranean. The Foraminifera from Ischia are generally of small size, probably indicating unfavourable conditions. The deposit containing them was probably formed in not very deep water, and more recently than the true Subapennine deposits; and the small size of most of the specimens, and the predominance of northern forms, would seem to show that the deposit took place when the refrigerating influence of the glaciers was beginning to be felt.

2. "On the Influence of the Advent of a Higher Form of Life in modifying the Structure of an Older and Lower Form." By Professor Owen, C.B., F.R.S., F.G.S.

In this paper the author, after referring to the general question of the modification of the structure of organic forms produced by the action of external influences, indicated that, in connexion with this, changes in the nature of the prey of carnivorous animals ought to be taken into consideration. He inferred that cold-blooded aquatic animals formed a much greater proportion of the food of Mesozoic than of Neozoic Crocodiles, and pointed out as connected therewith the well-marked distinction between the amphicœlian and procœlian type of vertebræ respectively characteristic of the two groups. The procœlian character of the trunk-vertebræ better adapts that part of the body to be sustained and moved in air, and may be connected with the incoming in Tertiary times of mammalian prey inducing the Crocodiles to rush on shore. The Mesozoic Crocodiles were encased in a much stronger and more complete dermal armour than their successors, doubtless for their protection from the great Ichthyosaurs, Pliosaurs, &c., which coexisted with them; but as these passed away at the close of the Secondary epoch, the armour of the procœlian Crocodiles has become more scanty, and the diminution of weight and rigidity thus caused would favour progression in air, and the rapidity of movement required for capturing mammalian prey on land. The difference in the position of the palato-nares, and in other related gular and palatal structures, between the Mesozoic and Neozoic Crocodiles is apparently connected with the power possessed by the latter of holding submerged a powerful mammal without permitting the access of water to the posterior nostrils and windpipe of the Crocodile; and hence the author is inclined to ascribe a fish-diet even to those massive-jawed Crocodiles from the Purbeck (such as *Goniopholis crassidens* and *simus*), which in some respects might seem fitted to grapple with large and active mammals. The small size of the upper temporal apertures in Tertiary and existing Crocodiles is regarded by the author as a further proof in the same direction; these apertures are reduced by the progressive increase of the osseous roof of the temporal vacuities, which again is correlated with increase in the bulk and power of the temporal muscles, the main agents in biting and holding. The differences in the length and strength of the jaw, as a rule, testify in the same direction. Further, the fore limbs in Mesozoic Crocodiles are shorter than in Neozoic species, indicating that the former were more strictly aquatic in their habits, the fore limbs in all Crocodiles being closely applied to the body during rapid swimming, and small limbs being less obstructive than larger ones. On the other hand, they would be less efficient as a means of progression on land; and hence it may be inferred that the advent in Tertiary times of mammals frequenting the water-side, tempting the Crocodiles to make a rush upon the land to seize such passing prey, would lead to such strenuous action of the fore limbs as would account for the increased size and power of those organs in the Neozoic species. The author concluded with some remarks upon the influence of the above considerations upon our views as to the generic divisions of Crocodiles.

3. "Notes on a Crocodilian Jaw from the Coral Rag of Weymouth." By E. Tulley Newton, Esq., F.G.S., of H.M. Geological Survey.

In this paper the author described what he believes to be a fragment of the lower jaw of a Crocodilian, obtained from a greyish-brown sandy grit, probably belonging to bed 3 of Messrs. Blake and Hudleston's Sandford-Castle section. The specimen measures about 11 inches long, and includes portions of both rami. The right ramus contains the remains of 12 alveoli, some of which, notably the first, second, fourth, and fifth, contain fragments of teeth, which appear to have been directed very obliquely outwards and forwards. The portion of the left ramus preserved gives indications of 14 or 15 teeth. An impression of a tooth in the matrix gives a length of $1\frac{1}{4}$ inch for the crown of the larger teeth; their section was nearly round; but a young unused tooth is slightly compressed, with a distinct ridge running down each side and two smaller ridges on the inner surface. The general surface of the crown was covered with fine but distinct longitudinal ridges. The median area has a spindle-shaped portion separated from the rest by deep grooves, the surface of which is longitudinally grooved; and this character, according to the author, does not occur in either of the genera mentioned by M. Deslongchamps.

4. "Note on Two Skulls from the Wealden and Purbeck Formations indicating a new Subgroup of Crocodilia." By J. W. Hulke, Esq., F.R.S., F.G.S.

The author described a Crocodilian skull obtained by Mr. H. Willett, F.G.S., from the Hastings Sands near Cuckfield, in Sussex, and identified by that gentleman with *Goniopholis crassidens*, Owen, and another from the Purbecks near Swanage, in the collection of the British Museum, which he further compared with a third specimen from Brook, in the Isle of Wight. He had little doubt that Mr. Willett's specimen had been correctly identified, and thought it and the Brook skull were probably specifically identical. All these skulls belong to a group intermediate between the Mesosuchia and Eusuchia of Prof. Huxley. In the constitution and position of the palato-nares they most nearly resemble *Metriorhynchus Blainvillii*, Desl., among the Mesosuchia. The general contour of the skull resembles that prevalent in the typical Crocodiles, such as *Crocodilus rhombifer*. In the arrest of the nasal bones short of the anterior nares they rather resemble *Gavialis*, and still more the

Bornean *Rhynchosuchus Schegelii*, as also in the form of the palato-nares. From the combination of characters presented by these Crocodiles (which the author regards as representing two species of *Goniopholis*) and their geological age, the author proposes to place them in an intermediate subgroup, which may be designated Metamesosuchia.

MISCELLANEOUS.

On the Classification of the Stellerida. By M. C. Viguier.

In the various classifications of the group Stellerida, authors have chiefly made use of characters furnished by the external skeleton and the various accessory products, spines, granules, &c. which cover it. It appears to me that, without neglecting the data furnished by their examination, more precise characters may be derived from the teeth themselves and the internal parts of the skeleton, particularly the interbrachial arches and especially the piece which supports the teeth and which I therefore name the *odontophore*. The interbrachial arches have been figured in some genera, but the odontophores have never attracted particular attention; and, finally, it was not known that in the ambulacra of some Stellerida there are circlets of calcareous spicules analogous to those found in Echinoida, although not presenting the same regularity.

Such investigations cannot be conclusive unless they apply to a great number of genera. M. Perrier placed at my service all the disposable duplicates of the collection of the museum, and I have also been able to study several types in the living state at M. Lacaze-Duthiers's laboratory of experimental zoology at Roscoff. I have thus brought together thirty-seven species belonging to twenty-seven genera distributed in the different families; and the following are the results at which I have arrived.

In the first place we recognize the great and profound separation between the Asteriadæ on the one hand, and all the other families of the group on the other. In all the Asteriadæ the teeth are absolutely truncated on the mouth-side, and repose by a flat surface upon the odontophore, which is massive and presents on its lower face a double inclined plane in relation to the teeth. The latter, therefore, considering the extent of the surfaces in contact, can have little or no movement. The types examined are *Asterias glacialis*, *Stichaster aurantiacus*, *Pycnopodia helianthoides*, and *Heliaster helianthus*, *microbrachia*, and *Kubinyi*. The form of the teeth is the same in all cases, as also that of the odontophore in the first three genera. It therefore does not appear to me possible to separate the genus *Pycnopodia* from this family, as proposed by Mr. Agassiz, and to approximate it to *Solaster papposus*, which differs profoundly from it. In the genus *Heliaster* the odontophore is certainly the same; but to give more solidity to the oral ring, which is formed of very small pieces, it is soldered to a larger piece situated behind it, and on the oral surface of which it forms a projection which enables it to be easily recognized.

Passing to the other families we find that the teeth, which are more or less stout and more or less pointed, are never absolutely truncated on the oral side, and that, in the general plan of the mouth, they have acquired a preponderance over the first ambulacral pieces, whilst the reverse is the case in the whole family Asteriadæ. The odontophore, which is almost simple in the Echinasteridæ, in which the teeth are very feeble, appears everywhere else composed of a body and two more or less prominent small apophyses having articular surfaces. These apophyses fit into the cavities which result from the coalescence of the first ambulacral and interambulacral pairs; and in this way the teeth, instead of resting upon one plane, are free to oscillate round these apophyses. Peculiar muscles give rise to the movements of separation and approximation of each pair of teeth.

The following are the new groupings that I propose (the names of the species examined are placed in parentheses):—

The genera *Echinaster* (*E. sepositus*) and *Cribrella* (*C. oculata*) belong to the same family (Echinasteridæ), which is clearly differentiated from the rest. The genus *Mithrodia* (*M. clavigera*), which approaches them, must nevertheless, I think, be separated from them and form the type of a family, Mithrodidæ, which also has affinities with the Linckiadæ.

Solaster papposus and *S. endeca*, contrary to the opinion of Mr. A. Agassiz, are certainly two species of a single genus. Their affinities are with *Acanthaster* (*A. echinites*), with which they must form a family (Solasteridæ). The Linckiadæ, from which I separate the genus *Fromia* (*F. milleporella*), are enriched with the genus *Chætaster* (*C. longipes*), which formed part of the Astropectinidæ. A great division must be established in this family: on the one hand the genera *Ophidiaster* (*O. pyramidatus* and *O. ophidianus*) and *Scytaster* (*S. variolatus*); on the other the genera *Linckia* (*L. miliaris* and *L. diplox*) and *Chætaster*. In the former group the pieces that M. Gaudry called "interambulacraires internes," instead of going from the ambulacral piece to the second row from the furrow, pass to the third, the pieces of which are larger: we cannot therefore assign them a serial number.

In the Goniasteridæ there are, no doubt, great divisions to be made; unfortunately I have only been able to examine too limited a number of types. However, I shall separate *Pentagonaster* (*P. astrologorum*), with which I unite *Fromia*, from the rest of the family, in which I leave the genera *Pentaceros* (*P. reticulatus*, *muricatus*, and *turritus*), *Anthenea* (*A. articulata*), *Goniodiscus* (*G. Pleyadellæ*), *Culcita* (*C. Schmideliana*), and *Gymnasteria* (*G. carinifera*). But, I repeat, the study of other genera will introduce new groupings.

The Asterinidæ include *Asterina* (*A. gibbosa* and *A. calcar*) and *Palmipes*. *Palmipes membranaceus* is very distinct; but *P. inflatus* very clearly allies the genus to *Asterina* and even to *Porania* (*P. pulvillus*), which I propose to unite with this family, and which, in the classification of Müller and Troschel, formed, with the *Gymnasteriæ*, the genus *Asteropsis*. The *Gymnasteriæ*, on the contrary, belong, as we have seen, to the family Goniasteridæ, as is shown by the structure of their dentary apparatus and the presence of spicules in their ambulacra.

The Astropectinidæ, reduced to the genera *Astropecten* (*A. aurantiacus*), *Luidia* (*L. clathrata*), and *Ctenodiscus* (*C. corniculatus*), form a very natural family; but we must completely separate from them the genus *Archaster*, or, at any rate, *A. typicus* and *angulatus*, which, for the present, remain perfectly isolated.

I have been unable to study any specimens of the other families, and therefore preserve an absolute silence upon them, except to say that, from an attentive reading of M. Sars's memoir and an examination of his plates, I have arrived at the conviction that, in spite of its two rows of ambulacra and its other peculiarities, the genus *Brisinga* ought to be approximated to the Asteriadæ. Perhaps the odontophore may have undergone some such modification as it presents in *Heliaster*, although the figure does not prove much in this respect, but the teeth are certainly the teeth of Asteriadæ. This would be confirmatory of the opinion which led M. Perrier to believe in the presence in *Brisinga* of crossed pedicellariæ, which he regards as characteristic of the Asteriadæ.—*Comptes Rendus*, March 11, 1878, p. 681.

On the Aerial Respiration of some Brazilian Fishes. By Prof. Jobert. Report by Prof. Milne-Edwards.

M. Jobert, Professor at the Faculty of Sciences at Dijon, and at present in Brazil, was commissioned by His Majesty Don Pedro to make various zoological investigations in the valley of the Upper Amazon, a region the study of which was commenced some years ago in a brilliant fashion by Agassiz. We have as yet no information with regard to the general results obtained by M. Jobert, who was at Tubatinga, near the frontier of Peru, in the month of September last; but, recently, the Emperor of Brazil has addressed to the Academy, through General Morin, a memoir by this traveller upon a special subject of very considerable interest, namely, the peculiar mode of respiration of several freshwater fishes inhabiting that part of South America.

In a previous memoir M. Jobert had made known the occurrence of an aerial respiration in *Callichthys asper*, a Siluroid fish which inhabits the environs of Rio de Janeiro, and which has the power of living for a long time out of water. Like the common Loach (*Cobitis fossilis*) of Europe, this *Callichthys* frequently swallows bubbles of air, partly absorbs the oxygen from them by the walls of its digestive tube, and by the same course excretes carbonic acid gas, which is afterwards evacuated by the anus mixed with the unabsorbed nitrogen. There is consequently in these animals, which also respire by means of branchiæ like ordinary fishes, a complementary respiration analogous to the pulmonary respiration of the terrestrial Vertebrata, but having its seat in the intestinal canal; and M. Jobert has ascertained that in the *Callichthys* this tube presents in its anatomical structure peculiarities in connexion with this exceptional function.

In fact, M. Jobert has found, in the sublaminal portion of the intestine of this fish, a multitude of filiform appendages, arranged in tufts on the free surface of the mucous membrane, and composed essentially of blood-vessels. Up to a certain point these tufts are comparable to the respiratory organs discovered by Réaumur in the rectum of certain larvæ of insects, and formed by prolongations of the tracheary system. Just as these internal branchiæ enable the *Libellulæ* to live in the water during the first period of their existence, the sanguiferous appendages of the intestinal coat of *Callichthys* serve to maintain an accessory aerial respiration in those aquatic animals.

In the memoir upon which the Academy has commissioned us to report, M. Jobert makes known the occurrence of a more or less analogous aerial respiration in several other fishes, the habits of which he has had the opportunity of studying in the valley of the Upper Amazon. These animals live in stagnant water, the temperature of which often exceeds 40° C. (104° F.); but this medium does not suffice to support their respiration, and they are obliged to come frequently to the surface to draw in air from the atmosphere. Sometimes, even, the drought drives them from their ordinary abode, and they are seen making journeys by land, of greater or less length, in search of more favourable localities; when thus engaged they crawl along the ground by means of their pectoral fins. Some of these fishes are peculiar species of *Callichthys*, and, like the *C. asper* of Rio de Janeiro, they have the faculty of respiring in two modes—respiring the air dissolved in the circumambient water, and which comes in contact with their branchiæ, and respiring also the atmospheric air which is introduced by deglutition into their digestive tube, traverses that canal throughout its whole length, and, afterwards escaping by the anus, produces a sort of continual bubbling in the water. M. Jobert had not at his command the necessary means for determining with precision the chemical composition of the gas which is thus evacuated; but he was able to ascertain that this fluid contains a large proportion of carbonic acid, and that it is less rich in oxygen than atmospheric air. Lastly, on studying anatomically the vascular tufts which clothe the walls of the intestine in which the air, in passing, loses oxygen and becomes charged with carbonic acid, M. Jobert ascertained that many of these sanguiferous appendages originate from adjacent veins, in the same way as the afferent vessels of a lung.

Other fishes of the Upper Amazon belonging to the genus *Doras*, and living in the same waters, resemble the species of *Callichthys* in their mode of aerial respiration, as well as in the structure of the mucous coat of the intestine in which this function is performed; and M. Jobert has ascertained that nearly the same thing takes place in the fishes known as *Hypostomi*. These animals also incessantly swallow air, and their intestine, into which the air is thus introduced, is almost equally rich in blood-vessels; but the air which has served for the intestinal respiration of the *Hypostomi* is not evacuated by the anus, and returns towards the mouth, to be expelled either by that orifice or by the branchial apertures. The complementary respiratory apparatus thus formed appears to be less perfect than in *Callichthys*: and, moreover, M. Jobert has ascertained that the *Hypostomi* are incapable of living so long out of the water as these latter fishes; they die within from five to seven hours.

M. Jobert has further ascertained the existence of a complemental aerial respiration in *Sudis gigas* and in certain *Erythrini* of the Upper Amazon; but in these fishes it is no longer the intestine that plays the part of lungs, but the so-called swimming-bladder is the seat of this function. Ichthyologists know that in the *Erythrini* this pneumatic sac, which communicates with the outer world by means of the œsophagus, is furnished internally with little alveolar chambers; but the walls of these cells, which had been studied only in animals preserved in spirits, were regarded as simple membranous folds, and in consequence most physiologists denied them the characteristic structure of a lung. M. Jobert has removed all uncertainty upon this point; he has ascertained that in these *Erythrini* there is really an aerial respiration which gives these fishes the power of living for a long time out of water, that these animals regularly renew the air contained in their pneumatic bladder, and that the walls of this organ are richly provided with blood-vessels, most of which originate from the venous system. Lastly, M. Jobert has ascertained experimentally that, by obstructing the canal by which this organ communicates with the atmosphere, the asphyxia and death of the fishes just mentioned are produced.

But all the fishes designated by zoologists by the generic name *Erythrinus* do not enjoy the faculty of living in this way out of the water. M. Jobert has found that the *Erythrinus trachina* of the Amazon is in this case; and this exception seems to corroborate the conclusions of the author as to the functions of the so-called swimming-bladder in the other *Erythrini*; for in the fish just mentioned, M. Jobert has ascertained that the cells and the venous network, so highly developed in *Erythrinus tæniatus* and *E. brasiliensis*, are wanting, and that the walls of the pneumatic sac are smooth.

We see therefore that the journey of M. Jobert in the valley of the Upper Amazon has already furnished physiological zoology with very interesting facts, which establish new bonds between the ordinary fishes, the Lepidosirens, and the perennibranchiate Batrachia, which possess at the same time branchiæ and ordinary lungs. The observations of M. Jobert on the intestinal respiration of *Callichthys* are equally important.—*Comptes Rendus*, April 15, 1878, p. 935.

Fossil Mammal from the Jurassic of the Rocky Mountains. By Prof. O. C. Marsh.

One of the most interesting discoveries made in the Rocky-Mountain region is the right lower jaw of a small mammal recently received at the Yale-College Museum. The specimen was found in the *Atlantosaurus*-beds of the Upper Jurassic, and the associated fossils are mainly Dinosaurs.

Dryolestes priscus, gen. et sp. nov.

This specimen is in fair preservation, although most of the teeth have been broken off in removing it from the rock. The penultimate molar, however, remains. The shape of the jaw, and the position and character of the teeth, show that the animal was a small marsupial, allied to the existing Opossums (*Didelphidæ*). The tooth preserved has the same general form as the corresponding molar of *Chironectes variegatus*, Illiger. The angle of the jaw is imperfect, but there are indications that it was inflected.

The principal dimensions of this specimen are as follows:—

	millim.
Space occupied by seven posterior teeth	12·5
Depth of jaw below last molar	4·4
Transverse diameter	1·8
Height of crown of penultimate molar	2·0
Transverse diameter	1·5

The present specimen indicates an animal about as large as a weasel. It is of special interest, as hitherto no Jurassic mammals have been found in this country.—*American Journ. Sci. & Arts*, June 1878.

Yale College, New Haven, May 13, 1878.

On a rare Form of the Hepatic Organ in the Vermes. By M. J. Chatin.

In most Vermes, the liver, represented by a cellular layer which lies on the wall of the intestine and covers it for a greater or less extent, seems to differ profoundly from the same organ in the Mollusca, Crustacea, &c.

The examination of certain types shows, however, that this distinction is far from being so absolute as might be imagined at first sight; and in some Annelids belonging to the Hirudineæ (*Pontobdella*) or to the Chætopods (*Aphrodite*) the biliary secretion tends to become localized in small cæca inserted upon the sides of the intestinal canal. These cases, however, which are almost always coincident with particular states of the digestive tube, are too rare and too imperfect to evidence a true morphological relationship with the arrangements proper to the higher Invertebrata. The latter are, on the other hand, realized in all their essential characters in a Helminth which I have lately been enabled to study, and the examination of which is most instructive in this point of view.

This Nematoid worm, belonging to the group Agamonema, Dies., lives encysted in the muscles of various fishes, and was sent to me by M. H. Filhol, who obtained several examples of it during his stay in Campbell Island. In this species the initial or œsophageal region of the digestive tube is rather slender, and presents no other glands than small follicles of irregular contour and containing a viscid, hyaline liquid, in which are scattered fine greyish granules. The middle intestine, which follows, is easily recognizable by the difference of its diameter from that of the preceding portion; but this difference is due less to a considerable increase in the calibre of the intestinal canal, than to the development of an exterior brownish mass which surrounds it and seems to become confounded with it.

If this mass be torn to pieces and observed with a power of 120 and then of 360 diameters, it is found to be composed of glandular tissue. It consists, in fact, of a multitude of cæca bounded by a fine membrane which is slightly thickened at the periphery; in their interior appear a great number of rounded, brownish or yellowish granules; the absence of epithelial elements is easily explained by the state of the animal.

The structure of the organ, recalling in all its principal features the constitution of the liver in the Crustacea and Mollusca, and its relations like those which the organ affects in some of them (Squillidæ, &c.), obliged us to consider it as a new form in the Vermes, and show that, if most of these animals diverge in this respect from the other Invertebrata, there are some nevertheless which approach them, and like them possess a true hepatic gland.—*Comptes Rendus*, April 15, 1878, p. 974.

Wartelia, *a new Genus of Annelids, erroneously regarded as Embryos of* Terebellæ. By M. Giard.

In 1845, after describing and figuring the transformations of *Terebella nebulosa*, Mont., M. H. Milne-Edwards said that he was inclined to believe that, from ignorance of these metamorphoses, the larvæ of *Terebellæ* might have been taken for distinct types, and thus the number of genera might have been uselessly increased. Since then the larvæ of the Annelids have been much studied, and the opposite mistake has rather been made, chiefly owing to these studies having been directed too much to larvæ captured in the muslin net, and too little to the more difficult task of rearing the animals from the eggs. It is thus that Claparède, in his 'Beobachtungen über Anatomie und Entwicklungsgeschichte wirbelloser Thiere an der Küste von Normandie angestellt' (pp. 63–69, pl. viii. figs. 12, 13, and pl. ix.), describes and figures, as stages in the evolution of *Terebella conchilega*, some young Annelids which really have no genetic connexion with this type.

M. Giard has recently found the same Annelid at Wimereux. It lives in the adult state upon the Hydroid *Laomedea gelatinosa*, on the branches of which small transparent projecting tubes may often be found, although, as they exactly imitate the gonothecæ of the Hydroid, they may easily escape observation. Each tube is inhabited by a pretty transparent Annelid, which only differs from the supposed embryo of *Terebella conchilega* (Claparède, pl. ix. fig. 6) by having its seven tentacles nearly of equal length, at least the median one does not nearly so much exceed the six lateral tentacles in length. The presence of the generative products in many individuals proves that they are adult. The existence of voluminous otocysts precisely like those of Mollusca, and the arrangement of the *tori uncinigeri* at the extremity of the ventral cirri of the posterior part of the body, lead to the location of this Annelid in a new genus much further removed from the *Terebellæ* than might be supposed, and presenting affinities with several families of Polychæta. This genus M. Giard names *Wartelia*, in honour of one of his pupils, M. Adolphe Wartel, who discovered the Annelid on the *Laomedea* at Wimereux; the species is named *W. gonotheca*, in allusion to the curious mimicry above mentioned. The arrangement of the tubes of *Wartelia* also gives them a certain resemblance to the tubicolar Rotifera.

This discovery leaves the embryogeny of *Terebella conchilega* completely unknown; and the best observations which we possess on the development of *Terebella* are those of Milne-Edwards on *T. nebulosa*, Mont.

Wartelia is probably allied to a tubicolar Annelid of the Mediterranean described by Busch*, and to the genus *Lumara* of Stimpson†. Perhaps also the larva figured by Agassiz ‡ as the embryo of *T. fulgida*, Ag., is the embryo of a form allied to *Wartelia*.—*Comptes Rendus*, May 6, 1878, p. 1147.

On the Molluscan Fauna of New Guinea.
By M. C. Tapparone-Canefri.

The author gives the following as the results of his examination of the Papuan Mollusca and especially of a fine collection of 320

* Beob. über Anat. und Entw. einiger wirbell. Seethiere (Berlin, 1851), p. 71, pl. xi. fig. 7.

† Marine Invertebrates of Grand Manan, p. 30.

‡ "On the Young Stages of a few Annelids," Ann. Lyc. Nat. Hist. New York, vol. viii. pp. 320, 321, pl. vii. figs. 19, 19*a*.

species formed at Port Dorey by M. Raffray and now in the Paris Museum.

Five sixths of M. Raffray's collection consist of marine Gasteropods; a few terrestrial Pulmonata and fluviatile forms and eighteen Bivalves complete the collection.

Among the marine shells nearly all the great Lamarckian genera are represented. The genera *Conus*, *Mitra*, *Turbinella*, and *Strombus* are the richest; but there are also a good many species of *Cerithium*, *Purpura*, *Ricinula*, *Nassa*, *Columbella*, *Triton*, *Ranella*, *Murex*, *Ovula*, *Cypræa*, *Trochus*, and *Turbo*. On the whole these shells show clearly that the Papuan marine molluscan fauna is closely related to the great fauna of the Indo-Pacific region, and especially to that of the Moluccas.

The terrestrial molluscan fauna of New Guinea has a more special character and appears to be much more related to that of the islands of Oceania, the Solomon and Admiralty Islands. The forms and the types are the same, although the species are different. This view is confirmed by the few terrestrial species in M. Raffray's collection. Nearly all the *Helices* must be placed in the groups *Papuina*, *Geotrochus*, *Cloritis*, and *Albersia*, and *Leptopoma* predominates among the Operculata.

In this collection there are two interesting forms which the author regards as quite new. One of them forms the type of a new genus, which the author names *Perieria*, after Professor Perier, and characterizes as follows:—

Genus Perieria.

Testa sinistrorsa, fusiformis, multispira, apice truncata: apertura elliptica; peristoma continuum, expansum; axis sinuosus, basi contortus et columellam truncatam atque subdentatam simulans.

This genus approaches *Clausilia*; but the want of folds in the columella, the false tooth at its base, and the truncation of the spire serve to separate the two genera. The species is

Perieria clausiliæformis, Tapp.-Can.

P. testa anguste fusiformi, crassiuscula, satis nitida, fusco-cornea, dorso (an fortuite?) albescente, peristomate pallidiore. Spira turrita, supra medium attenuata, apice decollata. Anfractus $7\frac{1}{2}$, regulariter crescentes, convexo-planulati, oblique et confertim per longitudinem inciso-striati, sutura impressa, subcrenulata sejuncti; ultimus major, basi subovatus. Apertura pyriformis, superne angustata, peristomate incrassato continuo. Alt. 0·065, lat. 0·012 m.

A new species of *Helix* is described as follows:—

Helix Raffrayi, Tapp.-Can.

H. testa latissime et profundo umbilicata, orbiculato-pyramidata, acute carinata, sub lente crebre per longitudinem striata, diaphana, corneo-cinerea, carina fulvescente, apice obtusiusculo. Anfractus $10\frac{1}{2}$, exsertiusculi, plani, sutura impressa, marginata divisi; ultimus valde convexus, ad umbilicum subangulatus, ad aperturam deflexus, disjunctus et subconstrictus; umbilicus maximus, conicus, apertus, anfractus omnes ostendens. Apertura rotundo-lunata, peristomate continuo, incrassatulo, undique expanso. Alt. $0{\cdot}005\frac{1}{2}$, lat. 0·010 m.

Comptes Rendus, May 6, 1878, p. 1149.

On a remarkable new Generic Type of Characins. By Theo. Gill.

More than ten years ago I discovered and laid aside in the museum of the Smithsonian Institution a specimen representing a previously unnamed genus of Characins, which was strikingly distinct from any recognized by other naturalists. I delayed the announcement in the hopes of being able to publish it in connexion with a revision of the whole family; but I deem it now expedient to introduce it without further procrastination. The genus may be called and distinguished as follows:—

Elopomorphus.

Curimatine Characinids with an elongated fusiform body; rounded belly; conic head with the operculum very oblique; mouth terminal and apparently transverse, but capable of considerable distention, the supramaxillaries being quite movable and the mandible inserted under the eye; the margins of the jaws trenchant; teeth none; the dorsal median and above the ventrals; the anal short; the gill-arches acutely bent and with prolonged limbs, and the gill-rakers very numerous and setiform.

Elopomorphus Jordanii.

The height of the body is contained about five times and a third in the (extracaudal) length, the length of the head rather more than three times and a half; the eyes are covered with a membranous coat; there are about 100 scales in the lateral line, and seventeen rows between the back in front of dorsal and the lateral line.

D. 11, A. 11, P. 10, V. (1) 12.

The colour, in alcohol, is rufescent and without decided markings.

The single specimen in the Smithsonian collection was obtained many years ago by Lieut. Gibbon from the Marmore River in Bolivia.

The *Anodus elongatus* of Spix seems to be a congeneric but quite distinct species.—*Field and Forest*, May 21.

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[FIFTH SERIES.]

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XIII.—*Studies on Fossil Sponges.*—II. *Lithistidæ.* By KARL ALFRED ZITTEL *.

[Plate VIII.]

A. GENERALITIES.

Since the publication of the first section of these "Studies" (see 'Annals,' ser 4, vol. xx.) the literature of fossil sponges has been enriched by a work of great importance. The first three parts of the fifth volume of F. A. Quenstedt's 'Petrefactenkunde Deutschlands' have appeared. These treat exclusively of fossil sponges. In sixteen folio plates the astonishing abundance of marine sponges in the White Jura of Swabia and Franconia is made manifest; and the figures in truth to nature and accuracy are certainly unsurpassed. Unfortunately Professor Quenstedt has disdained to pay any attention to the histological characters. Structural conditions are only referred to so far as they can be recognized with the lens; and thus the zoological value of this important work is essentially diminished. In the grouping of the different forms, geological occurrence and general habit are taken into consideration in the first place; a systematic treatment of the material in a zoological sense is, as a matter of course, not

* Translated by W. S. Dallas, F.L.S., from a separate impression communicated by the author, of his paper in the 'Abhandlungen der k. bayer. Akad. der Wiss.' II. Classe, Bd. xiii. Abth. i. pp. 67–154. The original memoir is accompanied by ten plates, from which some figures will be used, where necessary, for the illustration of this translation.

attempted; and it is left to the reader to summarize the observations made on the different species and to construct from them genera, families, &c. Quenstedt's monograph consists solely of descriptions of species; generic names are, indeed, occasionally proposed for particular groups, but are rarely consistently retained in the text, and never defined by diagnoses.

In the case of the latticed sponges the living Hexactinellidæ are occasionally referred to; but with respect to all other forms we find no indications of their position relatively to the sponges of the present day. In Quenstedt's latest publication, therefore, the fossil and living sponges are just as unconnected as in the works of Goldfuss, Michelin, D'Orbigny, Fromentel, &c. Admirably as Quenstedt brings out, by numerous figures, the external appearance and, in part, also the canal-system of the Upper Jurassic Lithistidæ, which are chiefly comprised under the generic names *Siphonia*, *Cnemidium* (*Cnemispongia*), *Tragos*, and *Planispongia*, we nevertheless gain not the least instruction as to their finer structural characters and systematic grouping. Hence the following investigations, carried out upon a different method and from different points of view, cannot be rendered superfluous by Quenstedt's monograph.

For the first certain evidence of the existence of fossil Lithistidæ we are indebted to Oscar Schmidt *. Soon afterwards (1871) H. J. Carter † recognized certain isolated siliceous bodies from the Greensand of Haldon as remains of Lithistidæ. Forked anchors and quadriradiate skeletal corpuscles of Lithistidæ are figured by Perceval Wright ‡ from the Chalk of Ireland, and by Rutot § from the Eocene sands of Brussels. Lastly, in a memoir on the fossil sponge-genus *Pharetrospongia*, W. J. Sollas ‖ states that the genera *Siphonia* and *Polypothecia* belong to the Lithistidæ.

I have now occupied myself for more than two years almost exclusively with the study of fossil sponges, and have already, at the annual meeting of the German Geological Society at Jena in the autumn of 1876 ¶, and also at the fiftieth meeting

* 'Grundzüge einer Spongienfauna des atlant. Gebietes,' 1870, p. 24.

† Ann. & Mag. Nat. Hist. ser. 4, vol. vii. p. 112.

‡ Rep. Belf. Nat. Field Club, 1873–74, Append. pl. ii. figs. 16–18, pl. iii. figs. 2, 3, 8–10.

§ Ann. Soc. Malac. Belg. tome ix. pl. iii. figs. 9–11, 22–26, 43, 45, 46.

‖ Quart. Journ. Geol. Soc. vol. xxxiii. (1877) p. 252.

¶ Zeitschr. deutsch. geol. Gesellsch. Bd. xxviii. p. 631.

of German naturalists at Munich in September 1877 *, made communications upon the organization, microstructure, and geological distribution of the fossil Hexactinellidæ and Lithistidæ, and illustrated them by the exhibition of microscopic preparations and numerous drawings.

This, so far as I know, is all that has hitherto been published about the occurrence of fossil Lithistidæ. The literature of the living representatives of this group is also of but small compass. The first forms belonging to it were described by Johnson †, Gray ‡, Bowerbank §, and Bocage ||, but, notwithstanding the peculiarity of their structural characters, were not separated from the other marine sponges with a vitreous (siliceo-fibrous) skeleton. It was only in the year 1870 that the examination of several species, newly discovered in the Atlantic Ocean, led Oscar Schmidt ¶ to establish a distinct order of Lithistidæ. Oscar Schmidt characterizes as Lithistidæ (*l. c.* p. 21) "the sponges with coherent siliceous tissue, the spicules of which do not grow in accordance with the triaxial type, but form an apparently quite irregular complication. In this, generally, a centrifugal and a concentric primary direction is recognizable, which, however, does not express the influence of a dominant spicular type, but adaptation to the general conditions of currents. Although their sarcode possesses properties which approximate them, to some extent, to the Hexactinellidæ, and, with these, probably to the fossil sponges, they approach very closely to the (other) living sponges in the canal-system, which is very indistinct in the former group. In external form there is no agreement within the family; but cup- and bowl-shaped species abound."

What this character wants in sharpness and definiteness is supplied by the careful descriptions and figures of eight species, which O. Schmidt distributes between the three genera *Leiodermatium*, *Corallistes*, and *Lyidium*.

H. J. Carter has published a complete summary and critical discussion of all the Lithistidæ known up to the year 1873 **. In this admirable memoir the characters of the Lithistidæ are established more clearly than by O. Schmidt, and the whole group is characterized as follows:—"Spicules developed upon

* Amtl. Ber. über d. 50. Versamml. deutsch. Naturf. und Aerzte in München, 1877, p. 161.

† Proc. Zool. Soc. Lond. 1863, p. 257.

‡ Ibid. 1859, p. 437, pls. xv., xvi.; 1867, p. 507; 1868, p. 565.

§ Ibid. 1869, pp. 66–100, pls. 3–6, and p. 323.

|| Journ. Sci. Math. Phys. et Nat. Lisb. 1869, no. iv.

¶ Grundz. Spong. atlant. Geb. 1870, p. 21.

** Ann. & Mag. Nat. Hist. ser. 4, vol. xii. (1873) pp. 349–373, 437–472.

a quadriradiate division of the central canal, held together by amorphous sarcode and an interlocking of their filigreed arms, forming a reticulated glassy structure, whose interspaces are more or less irregular and curvilinear. Composed of two kinds of 'skeleton-spicules,' viz. those which form a layer on the surface and are accompanied by minute or 'flesh-spicules' characterizing the species, and those forming the body, which are more or less alike in all the species and accompanied by fewer flesh-spicules. The skeleton-spicules of the surface, which, for the most part, are provided with a smooth, pointed, vertical shaft, directed inwards, and a horizontal head of different shape according to the species, will be termed 'surface-;' and the spicules of the body, which interlock with their neighbours through a filigreed development of all the arms, will be termed 'body-spicules.'"

Several deep-sea Lithistidæ, dredged up in the Atlantic Ocean by Prof. Wyville Thomson on board the 'Porcupine,' have since been submitted by Carter to an accurate analysis*.

A. Pomel, in his great work † on the fossil sponges of Oran (pls. A, B, & E), also gives figures of several living Lithistidæ. Unfortunately, however, an accurate description of the minuter structural characters is wanting to the genera *Cisselia*, *Ægophymia*, and *Pumicia* of Pomel; so that it can hardly be decided with certainty whether these agree with already known forms, or whether they are to be regarded as new genera or species.

External Form.

The external appearance of the Lithistidæ is exceedingly various, and even within the same genus is by no means constant. From the solid stony nature of the skeleton, we might have expected a greater constancy of form than in other sponges; but, notwithstanding this circumstance, we may apply to the Lithistidæ also the principle that the general form only plays a secondary part in the classification of the sponges, and can never be available for the characterization of orders or families.

The Lithistidæ most frequently imitate the forms of basins, cups, leaves, tops, and cylinders, but globular, pyriform, nodular, and amorphous bodies not unfrequently occur, whilst branched and bushy stocks are met with only in a few genera. They are generally adherent. In many the lower part of the sponge-body is developed into a longer or shorter stalk, which

* Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. (1876) pp. 460–468.
† Paléontologie de l'Oran, 1873.

is furnished with root-like processes at the extremity; others are attached to their support by a broad base, or may even, under certain circumstances, live as parasitic crusts upon foreign bodies; and only a few (*Aulocopium*, *Plinthosella*, *Spongodiscus*) appear to be destitute of any point of attachment.

From the Hexactinellidæ the Lithistidæ in general differ by their much thicker walls and by the denser texture of the siliceous skeleton. Thin-walled tubes, or mæandrically contorted delicate laminæ, such as are not unfrequently observed among the Hexactinellidæ (*Euplectella*, *Eurete*, *Plocoscyphia*, *Myliusia*), never occur among the Lithistidæ. The sponge-body consists of a compact stony mass of great solidity, which, when examined macroscopically reminds one rather of the structure of certain corals and Hydromedusæ with highly developed cœnenchyma than of that of the ordinary sponges.

The presence or absence of one or of several stomachal cavities has essential influence upon the external appearance. If a single central infundibuliform or tubular body-cavity sinks into a sponge-body of cylindrical, conical, globular, or pyriform shape, there can be no doubt as to the monozoic character of the latter. The genera *Aulocopium*, *Melonella*, *Cylindrophyma*, *Cœlocorypha*, *Scytalia*, *Pachinion*, *Siphonia*, *Trachysycon*, *Phymatella*, *Theonella*, *Discodermia*, *Isoraphinia*, &c. are in this case.

With equal certainty we may regard as polyzoic stocks those forms in which isolated large oscula with corresponding canal-depressions are distributed at considerable distances upon a nodular or ramified body, as, for example, in the genera *Astrobolia* and *Astrocladia*.

A phenomenon very characteristic of certain fossil Lithistidæ is the replacement of a simple stomachal cavity by a greater or less number of *vertical tubes*, sometimes grouped in bundles, sometimes arranged in series, sometimes irregularly distributed, penetrating the skeletal mass of the sponge-body in a perpendicular or nearly perpendicular direction, and usually reaching down to the base. These tubes are generally round, unramified, like quills, and nearly of the same diameter throughout their length, whilst the true stomachal cavities are always more or less narrowed downwards. Their orifices are situated in the vertex or at the upper margin of the sponge-body, which in most cases possesses a cylindrical, branched, or elongate-pyriform shape. In this group of Lithistidæ the question of their monozoic or polyzoic nature is difficult of solution. Their canal-system presents exactly the same characters as in the monozoic forms of the first group; and where reproduction takes place by gemmation, each branch possesses the same number of tubes as the parent body. If, therefore, we are to regard each of the above-described tubes as a separate stomachal cavity (as we are justified in doing, seeing that they undoubtedly serve as efferent canals), the sponges belonging to this category present examples of "syndesmotic" forms, in which each "person" is capable of existing only in conjunction with several others. The genera *Jerea*, *Thecosiphonia*, *Polyjerea*, *Marginospongia*, *Stichophyma*, *Jereica*, *Turonia*, *Doryderma*, *Carterella*, &c. serve as examples of this phenomenon.

The question of individuality becomes still more difficult in the cup-shaped and vase-shaped sponges. In these the wall encloses a central space which is very wide above and narrowed like a funnel below, the interpretation of which as a stomachal cavity is certainly open to doubt, although numerous similar radial canals of the same structure and direction open into it. In many cases the oscula of these radial canals attain a considerable size, and receive, on their own account, the access of special lateral canals; so that they themselves play the part of flues or stomachal cavities, and the whole sponge-body, like that of the common sponge, may be conveniently regarded as a composite stock. As, however, young stocks possess the same cup-shaped or vase-like form as the full-grown ones, as, further, the development of one of the above-described oscula into a distinct stock resembling the parent body has never been observed, and as these secondary stomachal cavities at the same time also act as radial canals of the whole colony, I leave the question of individuality undecided, characterize such "strobiloid stocks" as simple sponge-bodies, and place them in opposition to the "composite" ones, in which, by gemmation in various ways, several such strobiloid individuals of concordant habit are united into a colony. Here, therefore, as among the Hexactinellidæ, we probably have polyzoic forms which in their external appearance resemble a single individual, and, in a certain sense, are equivalent thereto. This conception finds further support in the fact that sometimes in one and the same genus the central cavity decreases in dimensions and becomes gradually converted into a wider or narrower funnel, the interpretation of which as a stomach can hardly be doubtful. In the case of the funnel-shaped and vase-shaped forms, moreover, one is always in face of the dilemma, whether the central space is to be regarded as the common efferent orifice, and the canal-system is to be conceived as a unitary and coherent system, or whether each large osculum, with the canal belonging to it, acts as a separate stomachal cavity. In favour of the latter assumption we have the fact that sometimes, in one and the same genus, together with cup-shaped species, there occur flat forms without any central cavity, in which the canals furnished with oscula manifestly serve as stomachal cavities. From such examples it may be seen that in the Lithistidæ, as in all sponges, the limitation of the individual is very uncertain and incomplete, and therefore can only be employed with caution in classification.

To the doubtful types of cup-shaped form (in which the question of individuality may be decided in either sense, according as we regard the sponge-body as a strobiloid stock or a simple person) the following genera belong:—*Verruculina*, *Amphithelion*, *Epistomella*, *Leiodorella*, *Hyalotragos*, *Azorica*, *Macandrewia*, *Corallistes*, *Leiodermatium*, *Callopegma*, &c.

If the presence of a simple stomachal cavity appears doubtful even in the vasiform Lithistidæ, it is certainly entirely wanting in a number of laminar, nodular, or disciform Lithistidæ, in which one or both surfaces are furnished only with small orifices, or even only with fine pores, from which fine canals penetrate more or less deeply into the sponge-body. These pores perform exactly the same part as the oscula in the preceding group, and may consequently be regarded either as the stomachal cavities of distinct individuals of a polyzoic stock, or as the mouths of canals of a simple irregular-shaped sponge-body. To this category we may refer the genera *Chonella*, *Seliscothon*, *Chenendopora*, *Ragadinia*, &c.

Finally, in a last group of Lithistidæ complete astomism prevails. The whole sponge-body consists of a loose, uniform tissue of skeletal elements, in the interspaces of which the circulation of water takes place without the aid of canals or stomachal cavities. The fossil genera *Platychonia*, *Lecanella*, *Bolidium*, *Mastosia*, and *Spongodiscus* furnish examples of this kind among the Lithistidæ.

Canal-system.

The water-circulatory system in the Lithistidæ presents greater variation than in the Hexactinellidæ, and even exceeds in multifariousness that of the Calcispongiæ. From the compact and thick-walled nature of most Lithistid skeletons, the conduction of water could generally be effected only by the formation of definite passages which remained free from skeletal elements. Then, as the latter were deposited around these constant aquiferous tubes, there was produced finally a regular lapidification of the canal-system, which enables us in the Lithistidæ to study the canal-system in macerated or fossil skeletons with as much certainty as in fresh specimens.

Six different modifications of the water-circulation may be distinguished in the Lithistidæ :—

1. A special canal-system is entirely deficient.

2. From one or both surfaces, finer or coarser, arched and frequently ramified canals penetrate, to a greater or less depth, into the wall.

3. Simple or branched, more or less curved canals run in a nearly horizontal direction from without inwards, and terminate in the stomachal cavity, whilst a second system of similar radial canals traverses the wall in a centrifugal direction and opens at the surface.

4. Simple, straight, often capillary radial canals traverse the wall in a centrifugal direction from within outwards; besides these there is sometimes a second system of curved canals running more or less parallel to the outer surface, and opening into the stomachal cavity.

5. The sponge-body is traversed by vertical tubes, to which radial canals are frequently superadded.

6. The whole wall consists more or less distinctly of perpendicular skeletal lamellæ or wedge-shaped segments, between which the water-circulation takes places in a radial direction.

The first and simplest case, that of the complete deficiency of a true canal-system, occurs only in a few genera of globular, disciform, or nodular form (*Spongodiscus*, *Lecanella*, *Platychonia*, *Bolidium*, *Mastosia*). In these the entire water-circulation takes place solely through the larger or smaller interspaces of the skeletal substance. On the surface there are no large oscula; and in these forms there is also never a stomachal cavity: either the surface presents exactly the same structure as all the rest of the sponge-body (*Spongodiscus*), or the substance of the skeleton becomes a little condensed and leaves only fine roundish pores (*Bolidium*, *Mastosia*).

From this simplest arrangement we find all intermediate steps to the second modification, in which the surface is covered with larger or smaller orifices, from which more or less curved canals penetrate into the interior of the wall. In the external form of these Lithistidæ the cup, vase, basin, or laminar form prevails. In certain genera (*Chonella*) the orifices are scarcely $\frac{1}{2}$–1 millim. in diameter, like pores, and corresponding to this the canals also are fine and but slightly developed. The laminiform or cup-shaped sponge-bodies also therefore possess no distinct stomachal cavities, unless the wide central space of the cup is to be regarded in this light. Sometimes both surfaces are similarly constructed, and the canals penetrate from both sides into the skeleton, either as simple, at first somewhat curved, tubules, or dividing as they pass inwards into two or three branches. Such an abundant ramification as Häckel has described in the Leucones I have never observed in the Lithistidæ. Penetrating canals, traversing the whole thickness of the wall, are also deficient in the whole of the second group; but there are certainly cases in which the canals only terminate immediately beneath the opposite surface (*Chenendopora*).

The two canal-systems, running in opposite directions, are not always equally developed. Very frequently one surface bears oscula, measuring 4–5 millims. or still more, and either depressed (*Hyalotragos*, *Chenendopora*) or prominent and margined (*Verruculina*, *Epistomella*, *Macandrewia*, *Azorica*), while the other is merely covered with fine pores. The one system is then reduced to a capillary net, whilst the other principally provides for the efflux (and perhaps also the influx) of water. In general, in the cup-shaped sponge-bodies, the larger oscula are situated on the inner surface (*Verruculina*, *Corallistes*, *Macandrewia*); but the contrary case may also be met with (*Leiodermatium*). If both surfaces are beset with larger oscula (*Leiodorella*, *Amphithelion*), a conclusion may be arrived at from the size of the orifices as to the development of the canal-system.

The third modification of the canal-system appears only in genera with a well-developed stomachal cavity of cylindrical, trochiform, or some similar shape. If we regard the wall of the stomach as the inner surface of a cup-shaped sponge-body, all that has been said as to the course of the canal-system of the preceding group applies also to the present one. The ostia of the radial canals opening towards the stomachal cavity are distributed either in series or quite irregularly. The canals penetrating from them into the wall are curved in a somewhat undulated manner, rarely straight; towards the outside they gradually diminish in size, at the same time sometimes forking into a few branches. Similar canals originate in the interior of the wall, and take their course in a radial direction outwards, where they open at the surface in larger or smaller ostia. The genera *Cylindrophyma*, *Phymatella*, *Calymmatina*, *Megalithista*, &c. possess a canal-system of this kind.

In a fourth group of globular, pyriform, top-shaped, or cylindrical sponge-bodies, usually with a narrow central cavity, straight (sometimes capillary) canals run in a horizontal or oblique direction from the centre towards the periphery and open at the surface as fine pores. These canals exist in great number and are pressed close together and never ramified; they give the sponge a fibroid structure in transverse or longitudinal sections. Frequently the canal-system of the preceding group is combined with these radiating radial canals. As typical genera of this kind may be mentioned *Cœlocorypha*, *Scytalia*, and *Pachinion.*

The canal-system becomes rather more complicated in the fifth group, to which *Aulocopium*, *Siphonia*, and some allied genera belong. In these, curved canals of considerable size, which are at first parallel to the periphery, but become almost perpendicular towards the middle, open into the funnel-shaped stomachal cavity. Besides these bowed canals, simple, straight, radial canals of the same or smaller size run in an oblique direction from within outwards: their number is in inverse proportion to their diameter; so that in forms with thick radial canals (*Siphonia*, *Melonella*) comparatively few are present, whilst sometimes (*e. g.* in certain *Aulocopia*), by their capillary nature and closely approximated position, they almost give rise to the appearance of a fibrous structure. This modification of the canal-system has already been admirably figured by F. Roemer * in the genus *Aulocopium*, by Quenstedt † in *Melonella*, and by Sowerby ‡ in *Siphonia.*

A very characteristic form of canals in the Lithistidæ are the vertical tubes, which have already (p. 117) been described. These frequently appear to replace the central cavity (*Jerea*, *Jereica*, *Stichophyma*, *Carterella*). They are either collected into bundles, or are more isolated and traverse the whole length of the sponge-body in the form of round tubes; in ramified stocks the principal stem and all the lateral branches are penetrated by such tubes. Their walls are usually furnished with pores, the apertures of fine radial canals. If the skeleton is of very loose texture and the vertical tubes are closely approximated, the latter may acquire a polygonal section, when they are generally separated from each other by thin walls (*Hyalotragos*, *Pyrgochonia*). Radial canals of the most various kinds may be combined with these tubular canals.

A last type of canal-system seems to occur, so far as I know, only in a few Lithistidæ. In these the entire, usually

* Die fossile Fauna der silurischen Diluvialgeschiebe von Sadewitz, Taf. ii. fig. 1^{c}, 2^{b}, 3^{b}, and Taf. iii. fig. 1^{b}, 2^{b}.

† Petrefactenkunde Deutschlands, v., Taf. 126. figs. 61, 62, 63.

‡ Fitton, "Strata below the Chalk," Geol. Trans. ser. 2, vol. iv. pl. xv^{a}. figs. 4–7.

thick wall of the cup-shaped, basin-shaped, top-shaped, or cylindrical sponge-body consists of vertical laminæ of small thickness, or of wedge-shaped segments, separated from each other by perpendicular clefts, which are either simple or divided towards the outside. By this means the whole sponge acquires a decidedly radiate structure, and in many cases reminds one of the calice of a coral with numerous radiating septa. The vertical clefts are bridged over at certain regular distances by skeletal layers, which consequently divide each cleft into a complete system of parallel radial canals standing one above the other. The latter penetrate the wall and open at the outer surface and on the wall of the central cavity in rounded or irregular pores. Striking examples of this form of the canal-system are furnished by the genera *Cnemidiastrum*, *Corallidium*, and *Seliscothon*.

Finally it may be mentioned that very frequently, at the surface where the growth of the sponge takes place, therefore especially at the vertex, the canals in course of formation appear as radiating furrows of very various nature, and up to a certain point indicate the course of the canal-system in the whole sponge-body.

Condition of the Skeleton and State of Preservation.

The skeleton of the Lithistidæ is remarkable for its stony, solid texture. The sarcode sinks into the background relatively to the siliceous deposits, and in living forms exists only in comparatively small quantity. As, moreover, the walls (or indeed the whole sponge-body) are of considerable thickness and usually traversed only by comparatively fine canals, the Lithistidæ must be reckoned among the most persistent and resistant of sponges. It is true that the small skeletal elements do not fuse together, as in the Hexactinellidæ, to form a coherent framework; but they are so closely interlocked that even after the death of the animal they do not fall asunder, so as to be scattered by the waves like the spicules of other siliceous sponges. This stony texture of the Lithistidæ specially adapts them for preservation in the strata of the earth; in fact a great proportion of the old Petrospongiæ belong to this group. Well-preserved skeletons, freed from matrix by muriatic acid, are scarcely distinguishable in their appearance and texture from the bodies of recent forms freshly macerated or newly taken from the sea.

There are certain localities, especially in the Upper Cretaceous of North Germany (Ahlten, Lemförde, and Linden in Hanover; Vordorf and Biewende in Brunswick; Coesfeld, Legden, and Darup in Westphalia), where the fossil Lithistidæ are to be obtained almost unaltered. We have merely to treat the fragments of rock with dilute muriatic acid to have before us in a short time the whole skeleton in perfect beauty. In the White Chalk of England and France, also, Lithistidæ, especially of the genus *Siphonia* (*Choanites*), sometimes occur which show the skeletal elements in excellent preservation enclosed in a crust of flint; but in these the canal-system is filled with a mealy siliceous substance, which cannot be removed by treatment with acid.

The above-mentioned skeletons behave, when examined microscopically, exactly like recent Lithistidæ. They possess the same optical properties as the latter in Canada balsam, resins, and glycerine. But this favourable state of preservation only occurs rarely.

In England the White Chalk of Flamborough Head appears to furnish the most numerous Lithistidæ; but although these specimens, after treatment with muriatic acid, show all the external characters of the sponge-body, and especially the canal-system, in wonderful beauty, they are but little adapted to microscopic examination. The individual skeletal elements, which are usually united to form fibres, are almost always soldered together by an accession of silica, more or less converted into crystalline silica, and so much altered that we can only exceptionally succeed in determining their original form. Certain specimens from the Coral Rag of Nattheim, and the Upper Jurassic strata of Muggendorf and Amberg, in the Franconian Jura, also behave in the same way.

A different process of silicification has taken place in most of the Lithistidæ from the Middle and Upper Cretaceous of France (Touraine, Normandy), as also in many from the North-German Cretaceous. In these the skeleton is certainly often well preserved; but flint has penetrated into all its interstices, so that it is useless to think of isolating its individual parts. Examination with a good power under the microscope leads most quickly to a determination in such cases; but for a more thorough investigation thin sections must be prepared. Under certain circumstances, however, fine translucent chips will suffice.

In Brunswick (near Boimtsdorf and Gliesmarode) Lithistidæ, preserved in the above manner and penetrated with flint, occur in great abundance in a derivative deposit (Diluvium). The skeleton is often of a dark colour and here and there somewhat decomposed, but in the main well preserved and capable of being shown in thin slices. Most of the Cretaceous sponges of Touraine present similar characters. In the latter, however, the process of decomposition has not unfrequently gone further: in thin sections we observe only isolated well-preserved skeletal elements, between which lie an immense number of blackish or reddish-brown spherules (probably of hydrated peroxide of iron), which are sometimes quite irregularly dispersed, but sometimes have undoubtedly got into and completely fill the empty forms of previously existing skeletal elements which have been washed out.

In the English White Chalk and also in the neighbourhood of Rouen, amorphous flint-nodules occur in great quantities, from which, when split, beautifully preserved sponges are frequently set free. The sponge-body is enveloped by a white porous crust of decomposed flint. Between this and the sponge there is usually a thin layer of snow-white siliceous dust, in which there are numerous well-preserved sponge-spicules. The sponge-body itself either exhibits the state of preservation already described in the case of the Lithistidæ of Flamborough Head, or, still more frequently, its interior is completely filled with a homogeneous mass of flint, in which all sponge-structure is destroyed; in thin slices it appears as a homogeneous amorphous substance. The surface of the sponge, however, as well as all the parts covered with white siliceous powder, are generally excellently preserved, and are particularly well adapted for examination by direct light.

A less favourable state of preservation of the silicified Lithistidæ is that in which the original skeletal elements have been dissolved and carried off, and are now replaced by cavities in the siliceous mass, furnishing a more or less true negative picture of the skeleton which formerly existed there. Numerous specimens from Touraine, from the White Chalk of England, from the Greensand of Regensburg, and the Coral Rag of Nattheim, Gingen, Muggendorf, and Amberg show this phenomenon.

Similar "negative" skeletons, not, however, enveloped in flint but in phosphatic glauconitic calcareous sand, occur in the Upper Cretaceous of Saratow in Russia, where the cavities are also sometimes filled with brown ironstone. I have already called attention to this state of preservation (which also occurs in the Hexactinellidæ), in the first section of these "Studies."

Lithistidæ in which the original siliceous skeleton is replaced by rust-coloured hydrated peroxide of iron occur very frequently in the *Mucronatus*- and *Quadratus*-chalk of Schwiechelt, Peine, and Vordorf in Brunswick, sometimes near Ahlten in Hanover, in the White Chalk of France, also in the North-German, Bohemian, and Saxon Pläner, and frequently in the Franco-Swabian Jura.

Lastly, we have still to mention the calcified lithistid skeletons. Even in the specimens from the celebrated sponge-locality of Sutmerberg near Goslar, most of the siliceous skeletons of Lithistidæ show the commencement of a pseudomorphosis. If they are placed in dilute muriatic acid, a portion of the sponge-body is sometimes dissolved, and, indeed, generally the surface and the parts nearest to the surface. The rest of the skeleton consists of silica; in fact, the interior is not unfrequently thoroughly impregnated with flint.

If these siliceous parts of the skeleton be more closely examined, they generally show a dull corroded surface, and the finer adornments of the small skeletal corpuscles have for the most part disappeared. Optically they differ from living and other Cretaceous Lithistidæ in that they possess nearly the same refractive power as Canada balsam, and therefore must be examined in glycerine, oil, water, or some such medium. A similar behaviour is shown by the Lithistidæ from certain Upper-Jurassic localities in the Franco-Swabian Jura (Schauergraben, near Streitberg, Uetzing in Franconia, Sozenhausen, Pappelan, and Sontheim in Württemberg) and in the Cracow district (Wodna, Kobilany, Luszowice); only here, as a rule, the calcification has advanced much further than at the Sutmerberg, so that during treatment with acid large portions of the sponge-body are destroyed. The remaining parts behave optically in the same way as the Hexactinellidæ occurring in the same locality*.

In general the pseudomorphosis of the Upper-Jurassic Lithistidæ is not confined to particular parts of the sponge-body, but the whole skeleton is usually converted throughout into calc-spar. In such forms the interspaces between the skeletal particles and the canals are without exception filled with stone, and, indeed, usually with limestone. In the Franco-Swabian Spongitenkalk of the White Jura β, γ, and δ, most of the Lithistidæ are completely calcified, and it is only now and then that a few siliceous skeletal corpuscles are obtained in the residue after treatment with acid. The same state of preservation is shown by the Lithistidæ from the upper and lower Spongitenkalk of Switzerland (Baden and Binnensdorf beds) and of the French Jura, the valley of the Rhone, the Cevennes, and the neighbourhood of Niort. In the Pläner of Saxony and Bohemia also the calcified skeletons predominate. I have already attempted to give an explanation of this remarkable phenomenon in the first section of these "Studies" ('Annals,' October 1877, p. 266).

It is remarkable that, in the pseudomorphosis of an origi-

* See the first section, 'Annals,' Oct. 1877, pp. 262, 263.

nally siliceous skeleton into calc-spar, in general no considerable change takes place in the form of the small skeletal parts. For example, if we cut a *Cnemidiastrum* or a *Hyalotragos* from the Swabian Jura at any point and examine the cut surface with the lens or under the microscope by direct light, the somewhat dark-coloured skeletal corpuscles, consisting of calc-spar, stand out sharply from the lighter rock-mass which has penetrated the sponge, and the structure may thus be recognized without further preparation. With a little practice mere examination with the lens, or, under certain circumstances, even with the naked eye, will suffice for the immediate recognition of the different genera of Hexactinellidæ and Lithistidæ.

Carter distinguishes three kinds of characteristic siliceous structures in the skeleton of the Lithistidæ:—

1. The true "skeleton-spicules" interwoven by means of sarcode and of thin filigree-branched ends;

2. The "surface-spicules," which are generally furnished with a vertical shaft; and

3. The so-called "flesh-spicules," uniaxial siliceous corpuscles, usually of small size, which lie freely in the sarcode, generally in the greatest abundance at the surface of the sponge-body, but also occur more or less frequently in the interior.

Of these three constituents, the small "flesh-spicules"* are deficient in all fossil Lithistidæ: but even in living specimens they can only be observed when the skeletons are still furnished with their sarcode coating; when the latter has been removed by decomposition, these minute corpuscles disappear with it.

According to the recent investigations of Sollas, the flesh-spicules are rapidly destroyed by alkalies; and therefore they could not long resist the process of fossilization.

Leaving out of consideration these little flesh-spicules, many Lithistidæ are further provided with large uniaxial bacillar spicules or cylinders, which also lie in great quantities at the surface or in the canals, and sometimes form a complete spicular coat. These large bacillar spicules appear, in certain fossil Lithistidæ, to replace the anchor-shaped surface-spicules, and may therefore be more particularly considered hereafter with them.

The denomination *spicules* does not apply very well to the

* Good figures of these little flesh-spicules are to be found in Bowerbank's "Monograph of the Siliceous Sponges," P. Z. S. 1869, pl. v. figs. 7 & 8, pl. vi. figs. 8 & 10–14, and pl. xxiii. fig. 6.

essentially skeleton-forming elements of the Lithistidæ, which constitute the principal mass of the sponge-body. These corpuscles are very seldom truly spicular in their form; they are never simple, straight, and pointed at one or both ends; but they are always composite, more or less branched corpuscles, and usually furnished with root-like appendages, which present but little resemblance to the siliceous skeletal elements of other sponges. I therefore regard it as inadmissible to speak of "skeleton-spicules" in the Lithistidæ, and will adopt the name of "skeletal elements" or "skeletal corpuscles" for them.

On the whole, a great uniformity prevails among the Lithistidæ with regard to the form of their skeletal corpuscles; so that it is only exceptionally that they suffice by themselves for the characterization of a genus.

In the most strongly marked and probably also highest Lithistidæ, almost all the constituents of the skeleton, both the true skeletal corpuscles and the surface-spicules, are quadriradiate, which, however, does not prevent one of the four rays being developed differently from the other three. I denominate this group Tetracladina. If we place any fragment of the skeleton of a *Phymatella*, *Siphonia*, *Callopegma*, *Aulaxinia*, *Turonia*, *Jerea*, &c. under the microscope, it is seen to be composed entirely of quadriradiate corpuscles similar in form and also agreëing pretty closely in size (Pl. VIII. fig. 1). All the four arms, of equal length, meet in the centre at angles of 120°; they are usually smooth, rarely beset with verruciform excrescences, and divided at the ends turned away from the centre into a few short branches, which again may be in turn beset with root-like processes. According as the four arms divide first of all into two or more thick branches, and these again into finer ramifications, or even into short fibres, there are produced at the ends pad-like dilatations composed of small root-like fibres. When well preserved, we may recognize in the interior of these siliceous corpuscles a quadriradiate cross of canals which represent the axes of an equilateral pyramid. The four canals meeting at the centre at 120° are often but short; they either cease before the first furcation of the arms, or divide by bifurcation and pass for a short distance into the two main branches, without, however, reaching the root-like processes. These canals are usually of capillary fineness; but sometimes they are considerably enlarged, probably by chemical action during the process of fossilization. In my memoir on *Cœloptychium** I have figured a number of such corpuscles

* Denkschr. bayr. Akad. Cl. ii. Bd. xii. Taf. vii. figs. 11–15, 20–23, 28, 32, 33.

from the internal skeleton of various Lithistid genera. Among existing Lithistidæ the genera *Kaliapsis*, *Discodermia*, *Rhacodiscula*, and *Theonella* approach the above-mentioned fossil forms.

The union of these corpuscles is effected as follows:—The dilated and ramified extremities of two or more arms of neighbouring quadriradiates come close together, whereby their root-like processes are so closely interlocked that the skeleton cannot easily break up into its individual particles.

In the genera *Spongodiscus* and *Plinthosella* the more or less regularly quadriradiate skeletal corpuscles are remarkable for their knotty structure and the slight branching of their arms. Almost the whole surface of these quadriradiates is beset with blunt, warty excrescences; one of the four arms is sometimes abbreviated, and their ends are somewhat thickened. The axial cross in the interior consists of four short, capillary canals, which may be much enlarged by subsequent influences*. The union of these warty quadriradiates is effected by the ends of neighbouring arms being brought close together, so that an apparently connected, coarsely fibrous skeleton is produced. In general, in the Lithistidæ, the whole sponge-body (leaving out of consideration the surface-spicules) consists of similar skeletal elements, so that it is a matter of indifference from what part of them a sample is taken for microscopic examination. In some Tetracladina, however (*Siphonia*, *Phymatella*, *Aulaxinia*), the base is distinguished from the upper, true sponge-body by a different microstructure. In these the normal quadriradiates, furnished with strongly furcate arms, become gradually more irregular below, and are in part converted into elongated siliceous fibres ramosely forked at the ends and also furnished with lateral processes. Between the elongated fibres there are a number of shorter branched skeletal corpuscles, which on the whole may be recognized as irregular quadriradiates (Pl. VIII. fig. 2). It is a remarkable circumstance that the root-elements, which are longitudinally distorted, do not possess four axial canals, but only a single and generally short central canal.

These last-mentioned root-elements serve to unite the Tetracladina with another section of Lithistidæ, which I group together under the denomination Megamorina (μόριον, particle) on account of their unusually large and elongated skeletal elements.

In these the quadriradiate structure almost entirely disap-

* Figures of such quadriradiates are given in my monograph of the genus *Cœloptychium*, pl. vii. figs. 16–20.

pears, or can only be exceptionally detected; but even in the latter case the four arms are always unequally developed and differently branched, and they do not meet in the centre at any definite angle. In certain genera, such as *Doryderma* (Pl. VIII. fig. 3), *Lyidium*, and *Heterostinia*, they are divided into several unequal branches, which again may fork into a few short and blunt lateral branchlets; in others, such as *Megalithista* (Pl. VIII. fig. 4) and *Carterella*, short branches originate at the ends of the elongated and curved skeletal corpuscles, diminish rapidly in thickness, and usually fork only once, or at the utmost twice. Besides these, short knobby processes spring from the main stem here and there. In the genus *Isorhaphinia* the skeletal corpuscles acquire nearly the form of simple, crooked, cylindrical spicules; but their thickened ends, often cleft into two short branches, prove them to be true Lithistid elements.

All Megamorina possess a simple axial canal, which sometimes traverses nearly the whole length of the main stem (fig. 4), but without ever making its appearance at the ends; but sometimes only forms a short capillary central canal in the middle of the branched skeletal corpuscle.

The skeletal corpuscles either compose alone the entire inner skeleton of the sponge-body (*Isorhaphinia*, *Doryderma*, *Lyidium*, *Megalithista*), or they are accompanied by much smaller, strongly ramified siliceous elements (*Heterostinia*), which in their general characters agree with those of the next group. The union of the large Megamorine corpuscles is effected by the curved ramified ends applying themselves to neighbouring skeletal corpuscles, and, indeed, frequently completely embracing them.

A small group of Lithistidæ, hitherto known only in the fossil state, is characterized by its irregularly ramose skeletal corpuscles, the branches of which meet in a nodosely thickened centre (Pl. VIII. fig. 5). As the branches are only moderately ramified at the ends, a meshed network is produced, which in many cases shows a great resemblance to the latticed framework of certain Hexactinellidæ, and, indeed, may be confounded therewith upon a hasty examination. By the furcation of the 4–7 usually smooth arms, these sponges, which I have proposed to denominate Anomocladina, are proved to be true Lithistidæ. The genera *Cylindrophyma*, *Melonella*, *Lecanella*, and *Mastosia* are the representatives of this group, from which, possibly, the Tetracladina have been developed.

In the great majority of the Lithistidæ the skeleton consists neither of these Anomocladine corpuscles, nor of distinct quadriradiates, nor of large, feebly ramified Megamorine elements, but of elegant and sometimes minute siliceous corpuscles, which are remarkable for their irregularly branched, many-pointed form (fig. 6). The slender, curved branches are either similarly developed, or one of them appears as the main stem in consequence of its greater length and strength, and from it the others are given off as secondary branches. The main stem and the branches are always set with root-like or wart-like simple or forked lateral processes. These filigreed corpuscles, from which I name this group RHIZOMORINA, not unfrequently fork into four principal arms, and then remind one of the Tetracladina; but it is very rarely that the four branches meet together at angles of 120°. In general, it may be said that no general law can be established for the Rhizomorina with respect to their ramification; they are irregularly formed, and show a definite typical form only within the same genus and species.

The presence of an axial canal is generally difficult to ascertain, as the round, toothed branches usually appear quite solid by transmitted light. But with favourable preservation and illumination I have been able to observe an axial canal in both recent and fossil Rhizomorina. In the Jurassic forms *Hyalotragos* (Pl. VIII. fig. 6), *Platychonia*, and *Cnemidiastrum* there is in the main stem a short, straight, simple axial canal closed at both ends; in the Cretaceous and recent Rhizomorina the wide, indistinctly limited axial canal, which sometimes shines through like a somewhat brownish nuclear stripe, follows the course of the main stem, and usually also sends ramifications into the larger branches, the smaller branches and the root-like processes being perfectly solid. O. Schmidt has figured such axial canals in *Corallistes microtuberculatus* (*l. c.* pl. iii. fig. 4) and *Corallistes typus* (*l. c.* pl. iii. fig. 3). Among the fossil Lithistidæ the genera *Seliscothon*, *Chonella*, *Verruculina*, &c. show the axial canals distinctly.

In the arrangement and union of these little toothed skeletal elements great variety prevails. Sometimes the fine processes of neighbouring corpuscles interlock to form a loose confused tissue, which, when treated with acid, either breaks up into its constituent particles, or sometimes remains loosely connected; or they group themselves close together and form anastomosing or parallel fibre-like bands, in which the particles, which are generally deposited in definite directions, are very intimately interlocked by their branches and root-like processes.

In the isolated siliceous structures which lie partly at the surface and in part scattered in the skeleton, and which are denominated "surface-spicules" and "flesh-spicules," greater variety prevails than among the true skeletal elements. They are either *uniaxial* or *quadriaxial* siliceous structures.

The former present no peculiarities worth notice. Bacillar spicules from 0·5 to 10 and 20 millims. in length may be observed in the most various modifications. They are usually spindle-shaped and pointed at both ends, sometimes blunt at one end and pointed at the other, or rounded off at both ends. Most frequently they are straight; but curved, S-shaped, and sometimes even undulated spicules occur. Their surface is smooth, rarely spinous. In an undescribed recent species, which I have received from Dr. W. Marshall, there are undulated spicules which are furnished at regular intervals with pointed frill-like processes, and in their habit resemble the form of spicule figured by Bowerbank in the Mon. Brit. Sp. pl. i. fig. 14.

The spicules of the quadriaxial type, to which it would be better to give Carter's name "trifid" or "ternate," are much more multifarious in form, as one axis is always differently developed from the rest and appears sometimes as a long shaft, sometimes as a short style, and sometimes only as a button-like thickening. Apparently perfect equality of the four rays never or extremely seldom occurs in the Lithistidæ. At least, I have never observed the so-called *chevaux de frise* either in living or in fossil forms.

Most frequently we find anchors with long simple shafts, diminishing towards the free end. The three prongs at the opposite end are rarely simple, and are then usually short (patento-ternate, recurvo-ternate, expando-ternate, incurvo-porrecto-ternate spicules, &c. of Bowerbank, *l. c.* figs. 45–54, 128, 129); but generally they divide again into two (rarely more) prongs, forming so-called double anchors (bifurcated expando-ternate spicules, Bowerbank, *l. c.* pl. v. fig. 130, and spiculated dichotomo-patento-ternate spicules, fig. 53, &c.).

In the simple anchors the three prongs either diverge obliquely outwards at equal angles or they are bent back. This is the case also in the forked anchors; but in these the three furcate prongs more frequently lie in the same plane, starting at right angles from the shaft, or their ends may even bend a little backwards. In my monograph of the genus *Cœloptychium* I have figured (Taf. vi. figs. 3–30, and Taf. vii. figs. 1–10) many such anchor-shaped structures, presumably all derived from Lithistidæ; so that any further description appears superfluous. Among these figures there are some (Taf. vii. figs. 9, 10) in which the arms of the forks are not smooth and straight, but furnished on the outside with branching excrescences. Similar furcate anchors beset with nodose warts also occur in some recent Lithistidæ (such as *Corallistes nolitangere*, fig. 7, *c*.)

A remarkable modification of the furcate anchor with arms standing perpendicular to the shaft is to be observed in the genus *Theonella*. Here the shaft is reduced to a short, pointed style, the three arms are compressed from above, curved, and divided at the ends into two short branches (see Bowerbank, *l. c.* fig. 306, and Proc. Zool. Soc. 1869, pl. v. figs. 8, 9). In the fossil genus *Rhagadinia*, and in an undescribed recent *Rhacodiscula* kindly communicated to me by Mr. Carter, the shaft is still shorter, and the very broad compressed arms divide into two, three, or more irregular lobes. In the centre there is a very short quadriradiate axial cross. Surface-spicules of this kind are figured in my monograph of *Cœloptychium* (Taf. vii. figs. 25–27, 29, 30). Carter has described similar forms from the Greensand of Haldon, under the name of *Dactylocalycites Vicaryi* *. If the shaft be reduced to a minute stylet, and the rays of the axial canal become still shorter, the depressed arms of the furcate anchor broader, and their lobate branches more numerous, structures are produced such as the short-stalked many-lobed siliceous disks represented in my monograph of *Cœloptychium* (Taf. vii. figs. 36, 37), or those figured by O. Schmidt (*l. c.* Taf. iii. fig. 8) as *Corallistes polydiscus*, Schm. (not Bocage), by Bowerbank (Mon. Brit. Sp. figs. 104–106) as "foliato-peltate spicules," and by Carter (*l. c.* pl. vii. figs. 3, 4) as *Dactylocalycites polydiscus* from the Greensand of Haldon. Similar minute disks occur in *Kaliapsis*.

Close to these come the sometimes circular, sometimes oval siliceous disks of *Discodermia polydiscus*, Bocage (see Bowerbank, Proc. Zool. Soc. 1869, pl. vi. figs. 10, 11), in which there are in the centre a minute conical stylet and a short quadriradiate axial cross. Carter (*l. c.* pl. vii. fig. 5) has also found the same disks fossil; and with these may probably be ranged the large irregular and angular siliceous plates of the fossil genus *Plinthosella*.

In the neighbourhood of *Discodermia* we must possibly also place those elegant siliceous disks with highly-developed and repeatedly divided radial canals, and perforated at the margin, of which I have already figured several specimens (*Cœloptychium*, Taf. vi. figs. 32–35). Similar disks are described by Carter from the Greensand of Haldon (*l. c.* pl. ix. figs. 40–42).

* Ann. & Mag. Nat. Hist. ser. 4, vol. vii. (1871) pl. vii. figs. 1, 2.

If we now return to the simpler, short-stalked, furcate anchors with curved arms of *Theonella*, we find that these are approached by other more complicated forms. Thus the shaft is reduced to a short conical style, and the curved arms emit lateral branchlets, which, in their turn, are beset with root-like excrescences. Elegant structures are thus produced (see Bowerbank, Proc. Zool. Soc. 1869, pl. v. figs. 2–4, and pl. xxv. fig. 4), which in their appearance considerably approach the true skeletal corpuscles. This resemblance becomes still greater when the short shaft itself runs out at its extremity into filigreed processes (*Azorica Pfeifferæ*, Cart.).

In these last-mentioned "surface-spicules," their relation to the skeletal elements is quite indubitable; but there are many, especially fossil, Lithistidæ in which the siliceous corpuscles of the surface, although differing in size and ramification from those of the rest of the skeleton, can only be regarded as modified skeletal corpuscles, but cannot be referred back to an anchorlike structure (*Leiodermatium*, *Leiodorella*, *Verruculina*, *Amphithelion*, *Seliscothon*, *Chonella*, &c.). I regard such "surface-spicules" merely as young still undeveloped skeletal elements.

The arrangement of the anchor-shaped surface-spicules is almost invariably such that the shaft is turned inwards and the prongs outwards. In *Corallistes*, *Turonia*, *Callopegma*, *Calymmatina*, *Theonella*, &c. the double prongs of the anchors, which diverge in the same plane, form a remarkably elegant stellate pavement, the interstices of which were occupied in the living state by sarcode and minute flesh-spicules. In *Doryderma* the anchors, which are furnished with short double prongs, are remarkable for the considerable length of their shafts. They are grouped together in dense tufts, and stick, with their notched ends outwards, in mesh-like depressions of the skeleton. The lobate and notched short-shafted anchors and the siliceous disks of *Discodermia* &c. also form a more or less dense surface-layer, which is the more perishable in proportion as the shafts, which are directed inwards, penetrate to a less distance into the mass of the skeleton.

As a rule, those surface-structures which, in their general habit, differ least from the true skeletal corpuscles, and are probably only young undeveloped skeletal elements, are placed very close together. Sometimes they form an apparently solid and smooth siliceous membrane, which either covers only certain portions of the sponge-body (*Turonia*, *Chenendopora*, *Thecosiphonia*), or else clothes the whole sponge as a regular fine siliceous envelope (*Calymmatina*, *Astrocladia*). D'Orbigny, Fromentel, Courtiller, and Pomel have repeatedly called attention to this peculiar covering-layer, but have frequently confounded it with the epithecal structures of corals or with the dense coat of the fossil calcareous sponges.

[To be continued.]

EXPLANATION OF PLATE VIII.

Fig. 1. Isolated skeletal element of the wall of *Callopegma Schlœnbachi*, Zitt., from the *Mucronatus*-Chalk of Ahlten. ×64.
Fig. 2. Skeletal elements of the stalk of *Aulaxinia sulcifera* (Röm.) from the *Mucronatus*-Chalk of Ahlten. ×32.
Fig. 3. Skeletal elements of *Doryderma dichotoma* (Röm.) from the *Mucronatus*-Chalk of Ahlten. ×32.
Fig. 4. Skeletal elements of *Megalithista foraminosa*, Zitt., from the Upper White Jura (ε) of Nattheim. ×32.
Fig. 5. Skeletal corpuscles of *Mastosia Wetzleri*, Zitt., connected and isolated, from the Upper White Jura (ε & ζ) of Sozenhausen, near Günzburg. ×64.
Fig. 6. Skeletal elements of *Hyalotragos patella* (Goldf.) from the White Jura of Streitberg. ×64.
Fig. 7. Anchor-spicule of *Chonella tenuis* (Röm.) from the *Quadratus*-Chalk of Linden, Hanover. ×64.
Fig. 8. Forked anchor of the surface of *Pachinion scriptum* (Röm.), from the side and from beneath. ×64. From the *Mucronatus*-Chalk of Schwiechelt, in Brunswick.
Fig. 9. Forked anchor of *Corallistes nolitangere*, Schmidt, from the side. ×64. Recent, Florida.

XIV.—*On* Bellidia Huntii *of Gosse*. By C. Spence Bate.

Having some time since communicated to Mr. Gosse my hesitation to accept his genus *Bellidia* (Ann. & Mag. Nat. Hist. Oct. 1877, vol. xx. p. 313, pl. 10) as that of a new or undescribed form, I took the earliest convenient opportunity to examine the specimen from which he drew up his description. This he sent to the British Museum, where it is carefully preserved.

I found it in the same condition and retained in the same bottle in which it was forwarded by the author, the peculiar chelate hand of the first pair of pereiopoda being detached and preserved with it.

It is needless to go into very minute details of the general characteristics of the animal, since careful, prolonged, and repeated examinations convinced me that the specimen was *Hippolyte Prideauxii* of Leach. Mr. Miers, the assistant in the Zoological Department under whose superintendence the Crustacea are, kindly assisted me to compare Gosse's animal with Leach's type of *H. Prideauxii*; and after comparing my drawings with Gosse's specimen, he agreed with me that the two animals were of the same species.

The arm of Mr. Gosse's specimen, upon which his genus *Bellidia* chiefly depended, is broken off at the *meros*. This fact, together with the probability that the animal was examined beneath a somewhat inadequate power of the microscope, is most likely the cause of the mistake being made by an observer so well known for his accuracy and extent of knowledge.

I should not have interfered now; but hearing from Mr. Gosse that "there is not the slightest probability of his going to London," the opportunity for him to correct his own observation might therefore be too long delayed.

I add a figure of the first pereiopod as drawn by Mr. Gosse (fig. 1), and another taken from the same by myself (fig. 2), to which I have conjecturally added the three missing joints.

Fig. 1.

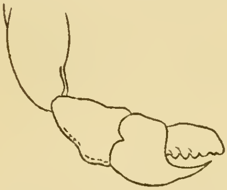
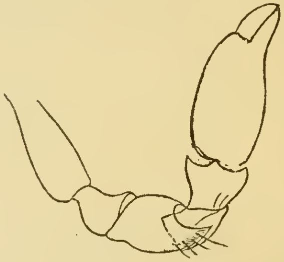


Fig. 2.



XV.—*Characters of four new Longicorn Coleoptera from Borneo.* By Charles O. Waterhouse.

Among the additions recently made to the British-Museum collection are four fine species of Longicorn Coleoptera, for which I have been unable to obtain names, and which I therefore here describe. One of them, which I have called *Pachyteria basalis*, very much resembles *P. Lambi* of Pascoe, from Penang; but the differences pointed out in the description, taken in conjunction with the difference of locality, justify me, I think, in regarding it as a distinct species.

Cerambycidæ.

Pachyteria ochracea, sp. n.

P. elongata, subopaca, ochracea; thorace antice posticeque nigro

marginato; scutello elongato-triangulari, nigro; pectore abdomineque violaceis.
Long. 20 lin.

Entirely deep ochraceous above. Antennæ with the three apical joints dusky. Eyes black. Thorax densely rugose on the disk, the lateral spine strong, the anterior and posterior borders black; the underside is bluish black with a yellow transverse stripe. Elytra very long, not much attenuated posteriorly, densely rugulose, but not quite so coarsely so as the disk of the thorax; the apices scarcely truncate.

Hab. Borneo.

This species much resembles *P. spinicollis*, but has the head and thorax differently coloured, the apices of the elytra are not "broadly truncate," and the anterior and posterior coxæ are yellow.

Pachyteria basalis, sp. n.

P. nigra, subnitida; antennarum articulis sex apicalibus elytrorumque dimidio basali flavis; thorace rufo.
Long. 15 lin.

Very close to *P. Lambi*, Pascoe (Proc. Zool. Soc. 1866, t. xliii. f. 6), but differs, so far as one can judge from the figure and description, in having six instead of seven joints of the antennæ yellow. The elytra are relatively longer. The underside is æneous-black, the abdomen tinged with piceous; each segment with a spot at the side of greyish-yellow pubescence.

♂. Abdomen with the 5th segment broadly emarginate; 6th segment below very deeply emarginate, the sides of the emargination parallel; above triangularly notched.

♀. Abdomen with the 5th segment below notched on each side.

Hab. Borneo, Sarawak.

Pachyteria ruficollis, sp. n.

P. viridi-ænea, nitida; antennarum articulis tertio ad quintum flavis; thorace læte rufo; elytris ultra medium utrinque plaga elongata velutina; corpore subtus plus minusve pubescentia griseo-flava ornato.
Long. 12 lin.

The six apical joints of the antennæ are deep blue-black. The thorax is bright red, with moderately strong punctures not very thickly scattered over the surface; the extreme anterior and posterior margins are edged with black; the lateral spine is short, tubercular. The elytra are bright metallic green, much attenuated posteriorly, rather thickly and very distinctly punctured; the suture is impressed towards the apex, and, like the apex, is closely and finely strigose-punctulate (as it were frosted); on the sides behind the middle there is an elongate slightly oblique velvety patch.

♂. Abdomen with the 6th segment broadly and strongly emarginate.

♀. Abdomen with the 5th segment triangularly notched in the middle.

Hab. Borneo, Sarawak.

Lamiidæ.

Etymestia alboguttata, sp. n.

E. nigra, subvelutina, plus minusve griseo-tomentosa; elytris guttis octo niveis; antennis nigris, articulis tertio ad septimum basi flavis.

Long. 13 lin.

Form and size of *E. Helena*, White, but totally differently coloured. Head and thorax black, with a little grey pubescence at the sides. Scutellum grey. Elytra with a few punctures on the shoulders, velvety black, with an oblique fascia close to the base, another in the middle, dentate, and a third at the apex, grey; the basal and mesial fasciæ united at the suture; each elytron has four round rather small white spots placed transversely two before and two behind the middle.

Hab. Borneo.

XVI.—*Note on* Cetonia opalina, *L. & G., with a Description of an allied Species.* By Charles O. Waterhouse.

The British Museum has recently received from two collections a species of *Cetonia* from Madagascar, which was referred to *Cetonia* (*Coptomia*) *opalina* of Lap. & Gory, but with some hesitation on account of the colour of the legs. With the view of ascertaining certain points I wrote to Prof. Westwood for some notes on the type in the Hopean collection; and he has kindly furnished me with the following valuable remarks, which show very clearly that the British-Museum examples are a distinct species.

"The type of *Cetonia opalina* (Hope), Lap. & Gory, is a male, and has Hope's label 'Mauritius?' It has a slight impression on the basal segments of the ventral surface of the abdomen; and the exposed lateral margins of the abdomen, seen from above, are dotted with white. Above it is olive-green, shining, with the scutellum, suture of elytra, and subapical tubercles more coppery. The lateral margins of the elytra, especially beyond the middle to the apex, have a broadish margin of transverse strigose rugosity. The pygidium is finely strigose, the strigæ arranged semicircularly. The posterior coxal plates have shallow oval punctures arranged obliquely. The mentum is pale greenish luteous. The femora are olivaceous; the tibiæ dark green, with orange hairs; the tarsi greenish black."

The following is the description of the species in this museum:—

Coptomia mutabilis, sp. n.

C. olivaceo-viridis, nitidissima; elytris regione scutellari nigro-cyaneo tincto, lateribus dimidio apicali striato-punctatis; pygidio lævi (♂) vel parce punctato (♀); antennis, tibiis tarsisque rufo-piceis.

Long. 11 lin., lat. $6\frac{1}{4}$ lin.

A broad highly polished species, with extremely fine punctuation on the thorax and some obscure lines of punctures on the elytra in the female. The deep-blue shadow around the scutellum varies in extent according to the direction in which the light falls. The pygidium has a few punctures scattered over the surface in the ♀. The lateral margins of the abdomen, seen from above, are dotted with white. The male has the 2nd, 3rd, and 4th segments impressed in the middle. The posterior coxal plates are nearly smooth, with two or three fine punctures only. The pubescence on the chest and legs is nearly black.

Hab. Antananarivo (*Rev. R. Joy*), Fianarantsoa (*Rev. W. Deans Cowan*).

XVII.—*Notes on the Embryology of Sponges.* By W. Saville Kent, F.L.S., F.Z.S., &c.

[Plates VI. & VII.]

Although the independent investigations of Metschnikoff*, Carter†, Oscar Schmidt‡, F. E. Schulze§, and, more recently, Barrois||, have, as a result, necessitated an important

* Metschnikoff, Zeitschr. wiss. Zool. Bd. xxiv. p. 1, 1874.
† Carter, Ann. & Mag. Nat. Hist. vol. xiv. pp. 321 & 389, 1874.
‡ Oscar Schmidt, Zeitschr. wiss. Zool. Bd. xxv. 2 Suppl., Nov. 1875.
§ F. E. Schulze, Zeitschr. wiss. Zool. Bd. xxv. 3 Suppl., Dec. 1875.
|| C. Barrois, Ann. des Sc. Nat. tom. iii. 1876.

modification of Prof. Haeckel's original interpretation of the so-called ciliated larvæ or reproductive gemmules of sponges, we can by no means be said to be in possession of an exhaustive knowledge of the histiological or developmental manifestations of these remarkable bodies. Our apprehension of the morphological affinities of the sponges as a class, again, assisted only by the dim and deceptive light derived from this same imperfect knowledge of these reproductive gemmules, is, as a natural consequence, encompassed by a still more perplexing mist of doubt and obscurity. Animated with the desire of contributing, however slightly, towards a more full and accurate comprehension of the true nature and affinities of that organic group with which these debatable structures are associated, I propose here to place briefly on record the results of an extended personal investigation of these special sponge-elements, paying attention more particularly to those phenomena observed which appear so far to have escaped the observation of the authorities just named.

As a preliminary introduction, it is scarcely necessary to remark that this embryological question is here approached from a direction diametrically opposite to that selected, with but one, if any, exception, by all of the before-mentioned investigators. These latter, although differing slightly among themselves in their individual interpretation of the structural elements of the so-called sponge-embryos, agree with one another, and, so far with Haeckel, in according to these bodies, and, *pari passu*, also to the adult sponges, the existence of two or more distinct cellular layers. This concession necessarily, and by these authorities avowedly, carries with it the inference that sponges are true tissue-forming Metazoa, and, at any rate, more nearly related to the simplest tissue-forming Cœlenterata than to the Infusoria or other typical Protozoa. Mr. Carter even commits himself so far, though perhaps not intentionally, to this metazoic interpretation as to continually make use of the terms "ectoderm" and "ectodermal layer" in his account of sponge-development. In accordance with the views adopted by myself, which are identical with those held by the late Prof. H. James-Clark, and as explained by me at some length in last January number of this Magazine, the sponges are compound colony-building collar-bearing flagellate monads, exhibiting neither in their embryological nor in their adult condition phenomena that do not find their parallel among the simple unicellular Protozoa, from which group, as a necessary consequence, this identity being established, they cannot consistently be held separate. The so-called "ciliated embryos" or "larvæ" of the various sponge-forms, following the same view, are regarded by me as the equivalent, not of a single body or person, but as a special aggregation of innumerable individuals to which collectively the title of "compound ciliated gemmules" or "swarm-gemmules" may be most appropriately applied. The chain of evidence supporting this decision, constructed out of the ample data yielded by the investigations of the several specialists mentioned, collated with my own in the same direction, may now be submitted.

The initial term or starting-point of the so-called ciliated sponge-embyro is generally recognized as consisting of a small unicellular *Amœba*-like unit possessing the faculty of locomotion from place to place by the protrusion of lobate pseudopodia after the manner of a typical *Amœba*. The diameter of the smallest of these initial units averages the 3000th part of an English inch, its appearance corresponding with that given at Pl. VI. fig. 2. From this most minute size these initial factors occur in every gradation to the dimensions of about the 200th part of an inch, under which larger proportions a spheroidal quiescent state is assumed and the first metamorphosis commences. This is effected by the symmetrical cleavage or duplicative division transversely and longwise, first into two, then successively into four, eight, sixteen, thirty-two segment-masses, and so on, of the entire spheroidal protoplasmic mass. The final result of this continued process is the production of a spherical aggregation of minute rounded units or segment-spheres, agreeing, to all appearance, with the morula derived from the segmentation or cleavage of the ovum of all ordinary higher animals or Metazoa. Figs. 3 to 8 of Pl. VI. serve to illustrate the leading phases of this transformation. According to Mr. Carter the foregoing process of cleavage takes place within a hyaline investing envelope; but the existence of such a structure is not confirmed by the investigations of Haeckel, Barrois, or myself. The next characteristic phase, universally conceded, is the assumption by the morula-like body of a more or less ovate outline, accompanied by the clothing of the entire peripheral surface with long vibratile cilia or flagella. This peripheral surface viewed superficially presents under high magnification a tessellated aspect, each minute polygonal area of this tessellation representing the external or exposed surface of one only of the innumerable segments into which the primary unicellular body has been divided. Pl. VI. fig. 9 represents such a superficial view, the cilia round the margin of the organism, for the sake of perspicuity, being alone introduced. Focusing a little deeper, so as to bring into clear view the centre of the entire body, which is thus seen as though in longitudinal section (Pl. VI. fig. 10), it will be found that the constituent cellular units or segment-masses have assumed an elongate conical contour, gradually tapering from the exposed peripheral border: the same being united by their posterior extremities, and closely adpressed to one another throughout their lateral extent, they, as it were, in fact, radiate from a common centre. Under these same conditions it is clearly shown that a single cilium originates from the centre of the peripheral border of each of these elongate units, and from its great proportional length may be more correctly designated a flagellum. Increasing in size, it is next found that these elongate units become separated posteriorly, leaving a central ovate or spherical cavity in the common body, while at the same time a short hyaline cup-like expansion develops around the base of the flagellum. This stage is represented in fig. 11 of the same Plate, and is also admitted in Barrois's drawings, and, with some slight modification, in those of Haeckel also. Upon this last there now, however, succeeds a phase which so far has apparently been overlooked by other observers, though it has been encountered personally in association with numerous sponge-forms, and constitutes, in fact, in accordance with the views here adopted as to the nature of these organisms, a natural sequence to the preceding. The aspect now presented is delineated at Pl. VI. fig. 12—the gemmule at this point of the development, as will be at once recognized, consisting of an ovoid aggregation of closely joined collar-bearing units in no way differing individually from the typical collar-bearing sponge-monads or spongozoa of which the adult sponge-body is composed. Each separate unit of this ovoid mass is at this stage of its existence a perfect individual collar-bearing monad, taking in an independent food-supply, which it captures with its collar of adhesive circulating sarcode in a manner similar to that already described by me of *Monosiga gracilis* and other free collar-bearing monads, in the last January number of the 'Annals'*. The morphological identity of the individual units of the sponge-embryo or gemmule with those of the independent monads alluded to becomes at once patent on placing side by side, as I have done at Pl. VI. figs. 13 and 14, the simple flagellate and adult collar-bearing condition of an independent freshwater monad,

* Mr. Xenos Clark, of the San-Francisco Microscopical Society, from whom I have just received a very complimentary acknowledgment of my recognition and support of his father's, the late Prof. H. James-Clark's, discoveries and theory concerning the nature of sponges, has very appropriately compared this sarcode-circulation of the hyaline collar as discovered by me to the action of an "endless revolving belt."

Monosiga angustata, S. K.*, with an isolated unit or zooid from the sponge-gemmule in the same simply flagellate and collar-bearing states. But for the accompanying explanation, indeed, the two might be interpreted as representing slightly varying individuals of the same specific type. Borrowing a simile from the vegetable kingdom, this matured and liberated sponge-gemmule presents now, as it swims through the water, a structural composition broadly corresponding with that of *Volvox globator*. The organism, as a whole, is propelled by the vibratory movements of the associated flagella; while, in the same manner, each unit of the compound body, viewed separately, exhibits that relationship towards *Monosiga* and other independent collar-bearing monads which is borne by those of *Volvox* with reference to such solitary types as *Diselmis* or *Chonemonas*. Sooner or later, the sponge-gemmule having transported itself, by aid of the concerted action of the countless vibratile flagella, to a spot suitable for attachment, the collars and flagella of the separate monads are retracted, and the organism becomes fixed, usually by one extremity, to the chosen fulcrum of support. An exuded veil of sarcode or syncytium is now poured out, hiding the monads from superficial view, and the transformation of the gemmule into a typical sponge-stock, as already detailed by Mr. Carter (*l. c.* p. 334 *et seq.*), is speedily effected.

In no one of the several phases passed through by this so-called sponge-embryo, as here recounted, can there be said to have been the formation of any distinct membrane produced by the uniting into one morphological whole of the cellular units or segmentation-masses, such as takes place invariably among all Metazoa, each of the separate units of this segmented body exhibiting a totally separate and independent existence. The only presumed metazoic characteristic manifested, indeed, by this ciliated structure is its primary assumption by continual subdivision of a morula-like condition. This moruloid condition, however, can be shown to be common to many undoubted Protozoa as well as Metazoa, the distinction between the two groups depending therefore upon the circumstance whether or not the component segments or blastomeres of this morula-like body maintain a separate existence or become welded into a single continuous tissue or blastoderm. Among those conspicuous instances in which a moruloid condition is exhibited by undoubted Protozoa, attention may be first directed

* An illustration of this and nearly forty other independent collar-bearing monads will be found accompanying an article on these newly discovered organisms, contributed by the writer to the 'Popular Science Review' for April 1878.

to the remarkable form recently described by Prof. Haeckel under the title of *Magosphæra planula*, represented by Pl. VII. figs. 13 to 18, and whose developmental phases correspond remarkably with those of the so-called ciliated sponge-embryo as just described. Placing our data in the same order of succession, we find first the reptant amœboid body, which assumes a rounded quiescent state, and then divides by a similar process of segmentation into a morula or spherical aggregation of rounded corpuscles. These separated segments or blastomeres now spread out on the surface, imparting to it a prismatic or tessellated aspect, as in the sponge-embryo, and further taper backwards and are united to one another posteriorly in a corresponding manner. We have now, indeed, only to add a hyaline collar and single cilium or flagellum to the peripheral border of each unit in place of the several cilia which clothe this region in *Magosphæra*, to produce a morphologically identical organism. What now becomes of *Magosphæra*? After swimming for a considerable while in the open sea, it breaks up or resolves itself into its constituent elements, each separated conical unit shortly afterwards losing or withdrawing its ciliary appendages and assuming an amœboid phase, identical with that from which the spherical colony-form first sprang, and prepared once more to repeat the cycle. A closely similar developmental cycle has recently been shown by Messrs. Dollinger and Drysdale to take place among many of the simple Monadina—an encysted spherical zooid splitting up by longitudinal and transverse cleavage into a morula-like aggregation, each segment of which develops into a distinct individual. My own recent investigations associated with this humble organic group have so abundantly confirmed the results of those of the authorities just quoted that I am inclined to regard this developmental cycle, in conjunction with another, referred to later on, as common to the greater portion of the representatives of the Infusoria Flagellata. The successive phases from the free-swimming monad to the moruloid stage of one of the most prominent types described and figured by the gentlemen last mentioned, in the 'Monthly Microscopical Journal' for January 1874, is reproduced at Pl. VI. figs. 27 to 33, and may be instructively compared with the similar cycle as it occurs in *Magosphæra* and the sponge-gemmules illustrated in the same and accompanying plates. *Polytoma uvella*, which is likewise figured and described by Messrs. Dollinger and Drysdale under the name of the "biflagellate or acorn monad," exhibits the same multiple fission or moruloid mode of reproduction—a fact amply attested even by such early investigators as Ehrenberg, Perty, and Schneider. A remarkable feature presented by the type last named is, that the flagella remain intact and the animalcule swims actively about while the segmentation of its entire interior substance is progressing.

One specially important factor associated with the developmental cycle of the ciliated sponge-gemmule, that has so far been quite lost sight of, relates to the initial condition of the so-called *Amœba*-like ovum, which by its segmentation develops into the compound structure. How is this presumed ovum produced? Haeckel and his followers regard it as the independent production of an imaginary entodermal tissue. I concede to it the position merely of metamorphosed collar-bearing sponge-monad, which having arrived at mature age has assumed an amœboid phase in a manner precisely identical with that which obtains in *Magosphæra* and among many of the simpler free-swimming monad forms just referred to. Such an assumption by the collar-bearing monads or spongozoa of an amœboid state has been personally witnessed over and over again, and is, moreover, amply confirmed, though not with the interpretation here submitted, by Haeckel, Carter, and all other authorities who have concentrated their attention on this organic group. The dimensions furthermore given by Mr. Carter of the smallest ovum-like body observed by him correspond precisely with those of a single collar-bearing spongozoon. As a final link in the chain of evidence it remains to be shown that a parallel mode of reproduction is associated with those independent collar-bearing monads that formed the subject of my last year's communication to the Linnean Society. A single example out of innumerable instances that might be quoted will suffice to demonstrate this fact. The solitary loricated type *Salpingœca fusiformis*, nobis*, represented at Pl. VI. figs. 21–26, exhibits precisely similar phenomena. Commencing first with the typical collar-bearing phase, it next assumes an amœboid condition, then, contracting into a subspherical quiescent state, splits up by symmetrical longitudinal and transverse cleavage into a spheroidal mass of minute segments or blastomeres corresponding essentially with that produced in a parallel manner by the so-called sponge-embryo. The further development of the ultimate segments or blastomeres is likewise identical. The most conspicuous primary transformation of the segmental units consists in both instances of the acquirement of a single flagellate appendage; and this is next succeeded by the growth of the characteristic collar. The only distinction subsisting between the two is, that while the individual units in the case

* Since figured and described by O. Butschli in Siebold and Kölliker's 'Zeitschrift für wissenschaftliche Zoologie' for January 1878, under the title of *Salpingœca Clarkii*.

of the sponge-product remain bound together in a social cluster throughout their metamorphoses, in *Salpingœca* they are scattered abroad, as shown at Pl. VI. fig. 26, during the immature or uniflagellate condition, their development to the adult state being afterwards effected during an attached and solitary condition. The matured collar-bearing spongozoa next throw around them, as already related, a common investing veil of glairy sarcode or syncytium, while the solitary *Salpingœca* builds for itself, by a similar process of exudation, its elegant-shaped protective sheath or lorica*; this at first is also soft and syncytium-like, but acquires an apparently chitinous or perhaps keratose consistence after short exposure to the water. The slight distinction between the two forms under the conditions last described finds its precise counterpart among the higher ciliate Infusoria, as instanced by the solitary lorica-inhabiting types *Cothurnia* or *Vaginicola* as compared with the social genus *Ophrydium*, the innumerable units of which exude around them and inhabit a common mucilaginous domicile. The social slime-dwelling form, *Phalansterium* of Cienkowski (*Monas socialis*, Fresenius), as compared with *Bicosœca* or other simple loricate Monadina, affords again a similar parallel among the more closely related ordinary Flagellata.

The further development to the characteristic adult sponge-form of the attached ciliated gemmule, the collars and flagella of the individual units being withdrawn and replaced by an investing syncytial mantle, has, as already mentioned, been described by Mr. Carter, with relation more especially to the siliceous-spiculed type *Halichondria simulans*, in this same magazine for November 1874. Barrois, again (*l. c.*), has traced these same developmental phases in a similar manner in numerous other sponges, including more prominently *Halisarca lobularis* and *Desmacidon fruticosa*. Among the phenomena connected with this further development, attested to by both these writers, is the early appearance of the spherical ciliate or monad-lined chambers which have received from Mr. Carter the title of ampullaceous sacs. How these chambers originate does not appear to have attracted the attention it deserves. Haeckel, however, has pronounced them to be mere spherical dilatations of the ordinary canals, while Barrois maintains that they make their appearance first as independent structures within the substance of the syncytium, communicating with the canal-system later on. This latter interpretation I am in a position not only to thoroughly indorse, but to further prove that these ciliated chambers are derived by a process

* This sheath or lorica, in order to economize space, is represented in its entirety in only one of the figures illustrative of this species.

of segmentation from a primary reptant amœboid and subsequently spheroidal unit in a manner identical with that already detailed of the free-swimming ciliated gemmules. Plate VII. figs. 1 to 7 serve to illustrate the successive phases of this development of a ciliated chamber as observed by me first in a species of *Halisarca* apparently identical with *H. lobularis*, and since confirmed by the investigation of innumerable other forms. Figs. 1 to 4 exhibit no deviation whatever from the normal process of segmentation producing the moruloid phase of the so-called ciliated embryo; and it is only when the separated units or blastomeres assume their next more characteristic and uniflagellate condition that the distinction becomes apparent. Here, as shown in section at fig. 5, the flagella are developed on the interior instead of the exterior border, and project into a central cavity instead of into the surrounding water. The matured development of the same chamber, in which the individual units or zooids have attained their typical form and characteristic collars, is similarly shown at fig. 7. As will be immediately recognized, it needs merely the eversion of this inward-turning spherical aggregation of collar-bearing monads to produce the typical free-swimming gemmule or so-called ciliated embryo represented by fig. 12 of the preceding Plate. At fig. 8, Plate VII., half a dozen monads from the same mature ampullaceous sac, but more considerably magnified, are delineated; and close to them (fig. 9) is placed, for the purpose of comparison, an example of an independent collar-bearing form, described by me in my monograph of the group under the title of *Desmarella moniliformis*. This type, which occurs somewhat rarely in salt water, forms small chain-like, free-floating colonies of from two to six or eight individuals only. Apart from the explanation here given, it would be scarcely possible to distinguish it from the separated spongozoa of the ampullaceous sac; and it affords another illustration of the close relationship that exists between the sponges and these more simple independent collar-bearing types. Throughout these latter, indeed, when extensively known, types are constantly recurring that manifest in their narrower cycle of existence a correspondence with some isolated developmental phase of the separated zooids of the former.

Although the symmetrically ovate shape, with the collars and flagella of the separate units forming an even and uninterrupted elegant frill-like border throughout the peripheral surface, as delineated at Plate VI. fig. 12, represents what may be accepted as the most typical and characteristic expression of the so-called ciliated sponge-embryo, it will be found that different examples of these bodies, derived even from the same sponge, present an extraordinary latitude of variation. Among the most conspicuous and frequent of these variations, is one which, indeed, in certain sponge-forms occurs almost as frequently as the typical one just alluded to; it is represented by Plate VI. fig. 15. The deviation in this example,. as will at once be recognized, consists of the distinct character of the component parts of the lower half of the organism, the typical elongate flagellate units which characterize the upper one being here replaced by irregularly spheroidal cells, which are more or less confluent with one another. Grasping at a straw, those committed to the metazoic interpretation of the Porifera have selected this inconstant type for the demonstration of their views respecting the bilaminate or diblastic structure of these bodies. No distinct inner and outer lamina, as first represented, being found to exist, the front flagellate portion is now made to do duty for the exoderm, and the hinder one for the endoderm. The constituent elements of this latter region being found again occasionally retreating into the central cavity of the compound body, this has been accepted as a proof of the invagination of the endoderm and the formation of a primitive "gastræa." The untenability of this interpretation, however, is at once proved by the inconstant occurrence of this type, while in addition it is easy to show that the basal and larger cellular elements are merely modifications or more advanced stages of growth of the smaller frontal ones. Two figures borrowed from Barrois (Plate VI. figs. 19, 20), representing two separate developmental phases of the ciliated embryo of *Halisarca lobularis*, assist in the demonstration of this fact. In the second of these (fig. 20) we find that the cellular units of the lower portion of the body, though abruptly larger than those of the upper one, exhibit the same uniflagellate character, while in the preceding figure the transition from one to the other is perfectly gradual and uniform. Another figure is given by this authority, derived from the same sponge-type, corresponding with our own fig. 10, but prior to the development of the flagella, and in which the component cells from one end to the other present a precisely similar size and character. Haeckel, again, in his 'Kalkschwämme,' Taf. 4. fig. 6, represents the ciliate embryo of *Ascetta clathrus* as corresponding entirely with my delineation at fig. 9 of that of *Grantia compressa*, the whole peripheral surface consisting similarly of minute even-sized cells, exhibiting in superficial view a tessellated aspect. No distinction whatever is indicated here between the cellular constituents of the anterior and posterior portions of the organism, though at the same time he delineates an apical aperture and central cavity, the latter lined with a separate layer of so-called endodermal cells, the existence of neither of which is any longer maintained. Still more direct testimony, if needed, in demonstration of the identity of the constituent elements of the upper and lower portions of the sponge-embryo, even where those of the latter one are of considerably larger size, is afforded by Plate VI. fig. 16, in which, as will be seen, the cellular elements of the lower portion exhibit all the characters of the adult collar-bearing zooids or units, while those of the upper part have arrived only at the semideveloped uniflagellate and collarless condition. This interesting example was met with in a calcareous sponge-form common on the Jersey coast, closely allied to Haeckel's *Ascandra pinus*, and having associated with it innumerable other embryos presenting the typical ovate and uniform character delineated in fig. 12. This somewhat abnormal example last described furnishes a complete key to the commonly occurring form delineated at fig. 15, this latter, indeed, representing a slight modification of the same type, in which the zooids of the lower portion have still further outstripped their antipodal companions in the race, losing their collars and flagella, and assuming the passive amœboid state accompanied by a syncytial exudation before these others have so much as developed the first-named structures. Why, in some instances but not in others, this disparity in the degree of growth should exist between the separate units or zooids of the anterior and posterior portions of the aggregate mass is easily explained. On making a suitable section through a sponge-body containing these embryos it will be found that in some cases these bodies are released from their syncytial matrix in their entirety, the zooids under these circumstances developing evenly throughout the periphery, while in others they for a while remain partially immersed within the same. In this latter case the zooids of the two opposite portions naturally develop at a different rate, those appertaining to the immersed one being temporarily retarded in their growth. In many instances indeed it would seem that the most posterior or deeply immersed cellular constituents do not perfect their final subdivision and development into the typical collar-bearing monads until the permanent attachment of the embryo. Mr. Carter has applied to these occasional larger cells at the posterior extremity of the ciliated embryo the title of root-cells, these same, when present, taken collectively, representing the region by which attachment to the selected fulcrum of support is most usually effected. It is a significant fact that, in cutting open or otherwise examining a young sponge shortly after this first attachment, the ampullaceous sacs in these sponge-forms, when they occur, are confined entirely to the basal region, and are evidently developed from the posterior root-cells.

Although the embryonic form last discussed, and which, from its peculiar contour and aspect, might be denominated the acorn-form, represents the most conspicuous and constantly recurrent deviation from the normally ovate type, innumerable other variations occur, presenting an altogether irregular and unsymmetrical shape. One of these irregular variations is represented at Plate VI. fig. 17, and another at fig. 18. In the latter of these certain of the cellular units have developed their flagellate appendages, while the others present the amorphous rounded form characteristic of those of the lower portion of the acorn type. In the former example a nest- or cup-like shape is assumed, not unlike the basal portion, taken separately, of the acorn variety, and in which the zooids are for the most part fully matured. Other variations might be figured and described without number; those given, however, suffice for the required purpose, that of demonstrating the non-persistency of contour of these so-called embryonic bodies. In addition to variation in contour, these same structures will be found even in one sponge-stock to vary among themselves considerably in calibre, notwithstanding that the component units or zooids exhibit a corresponding phase of development. Some of these bodies are several times larger than others, and contain necessarily a very much greater number of separate units. This non-conformity of the size of these unit-aggregations of like age appears to admit of two constructions. In the one case it seems highly probable that the primitive rounded *Amœba*-like mass from which these compound bodies are developed is built up, previous to its assumption of a quiescent state and subsequent segmentation, through the fusion or coalescence of a variable number of the original and typical collar-bearing zooids with which the sponge-cavities are lined, and in a manner parallel to that of the independent monad form illustrated by Plate VI. figs. 27 to 33, in which sometimes two only and sometimes a much larger number of zooids coalesce and produce by a corresponding process of segmentation a larger or smaller number of daughter zooids or macrospores resembling the parent. The coalescence of two *Amœba*-like sponge-units has been frequently observed; and it is not unreasonable to premise that a similar welding with one another, as in the case of the simpler monad, of a larger number of similar units is sometimes effected*. The abnormal and, in some instances, prodigious comparative size of the amœboid masses from which the ciliated embryo is developed admits, however, of a second interpretation. As shown by Haeckel in many of his illustrations (a portion of one of which, representing his *Ascaltis cerebrum*, is here reproduced, Plate VII. fig. 12), the external border of the amœboid mass is invested by a continuous and even layer of the normal flagellate monads. Now it has been demonstrated by me in my communication on this same subject to the Linnean Society last year, and has since been confirmed by repeated subsequent observation, that the amœboid particles or cytoblasts stationed within the substance of the syncytium, and which later on, under normal conditions, assume the typical collar-bearing form, receive their sustenance through the flagellate types, which, having filled themselves to repletion, pass all additional supplies, arrested by the hyaline collars, through their own bodies into the syncytium, where the same are at once seized by the amœboid particles. By a similar process it is not improbable that certain of these large amœboid masses, as indicated in the figure quoted, represent ordinary cytoblasts or imperfectly developed flagellate zooids, upon which the task of conversion into the ciliated swarm-gemmules specially depends—to which end they are, as it were, specially fed and fattened up by the superincumbent flagellate units. The falling-off or diminishing amount of the food supply might, under these conditions, arrest at any stage the further development of these amœboid masses, causing them to enter upon their final transformations at different epochs of growth, which would thus sufficiently explain the variable calibre of the ciliated bodies produced by subsequent segmentation †.

From the account now submitted of the developmental manifestations of the so-called ciliated sponge-embryo it is clearly evident that we have here represented merely a mode of increase, for a special purpose, by multiple fission, differing in no essential manner from that common to *Magosphæra* and

* Haeckel further describes and figures the coalescence of numerous individuals into one homogeneous amœboid mass of his simple monad form *Protomyxa* as a prominent feature in the developmental cycle of that type.

† That this suggested interpretation does not in any way militate against the conception of the unicellular and Protozoic nature of the essential Spongozoa is sufficiently demonstrated from the fact that among certain colony-forming higher ciliate Infusoria, and notably the genus *Zoothamnium*, special zooids are at times developed for a closely parallel object, and attain, in comparison with the ordinary units, an equally disproportionate size.

the independent collar-bearing types, such as *Salpingœca*, and the majority of the Infusoria flagellata. That these bodies cannot in any way be compared with the true ova of the ordinary Metazoa is demonstrated not only by their inconstant form and character, disassociated also with any act of spermatic fecundation, but from the fact that the segmentation of the primary unit gives rise to a morula-like aggregation, which does not develop by the fusion of its constituent particles or blastomeres into a single germ-lamella or blastoderm, but into a number of distinct and independent unicellular zooids or units. The Metazoic interpretation of the nature of sponges, as grounded upon the developmental manifestations of these same bodies, must likewise as a consequence be abandoned, or otherwise be extended to the simple Monadina, Radiolaria, and Catallacta, which produce a similar morula-like segmentation-mass, thus leaving the Protozoa in possession only of little more than an empty title. The true nature and significance of the so-called ciliated embryos of the sponge, while not reconcilable with the proposed Metazoic interpretation, becomes clearly intelligible on collating these organisms with the unicellular Protozoa. Regarded from this position, the identity of the ovate aggregation of separate units which constitute the so-called sponge-embryo with the similar aggregation of units of the segmented monad, afterwards separated and dispersed as swarm-spores, is made apparent. This sponge-embryo is in this manner demonstrated to be merely an aggregation of swarm-spores held closely bound to one another throughout the process of development. It may therefore be appropriately denominated a "swarm-gemmule," whose mission it is in its aggregate condition to lay the foundation of a composite sponge-stock similar to the one which gave it birth, and in a manner identical with that individually effected by each motile swarm-spore of the solitary monad.

As a final demonstration of the Protozoic nature of sponges, the multiplication of these organisms by the production of countless infinitesimal spores after the manner of the typical Monadina has been determined. This spore-formation is brought about through the assumption by the matured collar-bearing zooids of a quiescent encysted state, accompanied or not by the fusion of two individuals. The spores produced by the breaking up into almost invisibly minute particles of the entire protoplasmic substance of the encysted zooids are liberated in the substance of the syncytium; and within this matrix each spore develops again through an amœboid or cytoblastic and then simply flagellate phase to an adult collar-bearing unit. This multiplication of the typical sponge-monads or Spongozoa by the means of spores represents the constant and normal manner in which the growth and extension of the sponge-colony is effected—the aggregated masses of individuals or swarm-gemmules, liberated only at certain periods, representing a special development for the more extensive dissemination of the species. The subject of spore-formation, associated with the reproduction of sponges, has been already adverted to in my contribution to the 'Annals' in January last, and is entered into at considerable length in my communication made in June 1877 to the Linnean Society. Pending the publication of these more abundant details, figs. 19 to 25 of Plate VII. accompanying this article will assist to illustrate some of the more conspicuous phenomena that accompany this method of reproduction.

I gladly avail myself of the present opportunity of recording my most grateful acknowledgments to the Government-Grant Committee of the Royal Society, who, by their liberal award to me of a grant of £50, have placed at my disposal those instruments of precision not otherwise accessible, but absolutely requisite for the accurate determination of the ultimate structure and affinities of the group of organisms discussed in this communication.

Channel-Islands Zoological Station,
St. Heliers, Jersey, June 21, 1878.

EXPLANATION OF THE PLATES.

Plate VI.

Fig. 1. Typical spongozoon or collar-bearing monad of the calcareous sponge-form *Grantia compressa*, × 1000 diameters. *n*, endoplast; *c.v*, contractile vesicle.

Fig. 2. The *Amœba*-like body from the same sponge-form, out of which by segmentation the swarm-gemmule or so-called ciliated embryo is produced—which may represent either a typical sponge-monad, as at fig. 1, that has withdrawn its collar and flagellum, and assumed an amœboid phase, or a similar monad in its undeveloped and cytoblastic state.

Figs. 3–8. Successive developmental phases of the swarm-gemmule of the same sponge, commencing with the assumption by the last-named amœboid body of a spheroidal form, and terminating in the production of a morula-like aggregation of segment-masses or blastomeres.

Figs. 9, 10. The characteristic form of the swarm-gemmule when liberated from the syncytium of the parent sponge, viewed at fig. 9 superficially and at fig. 10 in optical section; the segment-masses of the preceding morula-like body have assumed a conical shape, radiating from the centre to the periphery, each of the same bearing in the centre of its exposed or distal border a single cilium or flagellum. × 350 diameters.

Fig. 11. Optical section of a portion of a still further advanced condition of the same swarm-gemmule, in which rudimentary collars have been developed around the distal flagella; through the enlargement and expanding outward of the cellular constituents a central cavity is now possessed by the common body.

Fig. 12. The fully matured condition of the same swarm-gemmule, which is now shown to be an ovate aggregation of typical collar-bearing monads similar to that represented at fig. 1, and of which the parent sponge-stock is essentially composed.

Fig. 13. Separated monads from successive developmental conditions of a similar swarm-gemmule, that at *a* possessing a flagellum only, and the other, *b*, being provided with its characteristic collar, contractile vesicle, and endoplast.

Fig. 14. Adult and immature conditions of a solitary collar-bearing flagellate monad, *Monosiga angustata*, S. K.,—*a* representing the collarless and immature one, *b* the adult form, and both exhibiting a remarkable correspondence with the similar developmental phases of the isolated sponge-monads given in the preceding figure. × 2500 diameters.

Fig. 15. An irregularly-formed acorn-shaped swarm-gemmule from the same sponge, in the anterior part of which the monads have not yet developed their collars, while at the posterior end the collars and flagella have been withdrawn, and the separate monads, coalescing laterally with one another, accompanied by the exudation of a syncytial film, have produced anamorphous amœboid mass.

Fig. 16. Another example of an "acorn-shaped" swarm-gemmule from the same sponge, in which the disparity of development between the constituent monads of the anterior and posterior halves is not so considerable; those of the latter present the characteristic adult collar-bearing form, while those of the anterior portion possess as yet only single terminal flagella.

Fig. 17. An irregular nest-shaped swarm-gemmule from the same sponge, composed of adult collar-bearing monads.

Fig. 18. An abnormal and entirely unsymmetrical swarm-gemmule from the same sponge-form, in which the constituent monads exhibit the two phases of development presented at fig. 15.

Figs. 19, 20. Two swarm-gemmules of *Halisarca lobularis*, in the first of which the as yet immature and uniflagellate monads correspond with each other in size, while in the second those of the lower portion are considerably more developed (after Barrois).

Fig. 21. Adult monad of the solitary collar-bearing loricate type *Salpingœca fusiformis*, S. K. (The lower portion of the lorica, to save space, has been omitted, but is represented in its entirety at fig. 26.) × 2000 diameters.

Fig. 22. The same monad, having withdrawn its collar and flagellum, assuming an amœboid state.

Figs. 23–25. Successive phases following upon the amœboid condition of the same animalcule, corresponding with those illustrated by figs. 3–8 of the sponge-monad, and terminating in the production of a similar morula-like aggregation of segment-masses or blastomeres.

Fig. 26. The segment-masses or blastomeres of the preceding morula-like body becoming separated from one another, and issuing from the parent lorica as simple flagellate monads or swarm-spores; these subsequently become attached, and grow to the adult state.

Fig. 27. An adult individual of Messrs. Dollinger and Drysdale's "hooked monad" (*Heteromita uncinata*, S. K.).

Fig. 28. Two individuals of the same species about to coalesce.

Figs. 29–33. Illustrating the coalescence or fusion of four individuals of the same type, followed by the production of an irregular amœboid mass, which finally resolves itself by a process of segmentation, and in a manner identical with that of the sponge-monad and solitary collar-bearing form last figured, into a corresponding morula-like body, the constituent units of which are finally liberated as minute zoospore-like bodies which grow to the parent form. Figs. 27 to 33, representative of this type, are reproduced from Messrs. Dollinger and Drysdale's figures.

Plate VII.

Fig. 1. *Amœba*-like corpuscle or zooid of *Halisarca lobularis*, out of which, by repeated segmentation and differentiation of the cleavage-masses, the characteristic spherical ciliated chambers or "ampullaceous sacs" are constructed. × 400 diameters.

Figs. 2–4. Various phases of this process of segmentation, terminating at fig. 4 in the production of a morula-like aggregation of rounded blastomeres.

Fig. 5. The succeeding developmental phase of the ampullaceous sac of the same sponge, as seen in optical section. The segment-masses have now spread out upon the surface and assumed a conoidal form, each of the same bearing apically a long lash-like flagellum, which projects into the common spheroidal cavity.

Fig. 6. An example of about the same age, focussed superficially, in which the segment-masses, while considerably separated from one another, are held together by the hyaline or syncytium-like wall of the body of the "sac," upon the inner surface of which their apices project.

Fig. 7. A fully matured ampullaceous sac of the same sponge, as seen in transverse optical section, and in which the previous conical, uniflagellate segment-masses have developed into typical collar-bearing sponge-monads or Spongozoa. The eversion of this matured monad-chamber is alone required to produce a structure essentially corresponding with the "swarm-gemmule" represented at fig. 12 of the preceding Plate. × 800 diameters.

Fig. 8. A few individual units or sponge-monads from the preceding figure, further enlarged: *n*, nucleus or endoplast; *c. v*, contractile vesicle.

Fig. 9. A colony of the independent, free-swimming, collar-bearing monad *Desmarella moniliformis*, S.K., which occurs in chain-like aggregations of from two to as many as eight individuals, with which the separated sponge-monads in the preceding figure essentially correspond. × 1000 diameters.

Fig. 10. Sporocyst-like bodies found associated with a siliceous sponge-form (*Halichondria*, sp.). × 600 diameters.

Fig. 11. Detached fragment of a siliceous sponge (*Halichondria*, sp.), showing at *a* an ampullaceous sac in its semideveloped or moruloid condition, at *b b* two amœbiform bodies emitting pseudopodia, and which after assuming a quiescent or encysted state, develop through the cleavage of their substance into ampullaceous sacs. *sy*, syncytium. Several typical adult sponge-monads or Spongozoa are shown at *c*.

Fig. 12. Portion of the cavity of a calcareous sponge (*Ascaltis cerebrum*, Hkl.), showing at *a* the internal lining of characteristic flagellate cells, and at *b* a swarm-gemmule in its earlier amœboid and unsegmented state. (After Haeckel.)

Fig. 13. An isolated zooid of *Magosphæra planula*, Hkl., derived from the dismemberment of the adult spherical colony form.

Fig. 14. A similar zooid with the cilia retracted and presenting an amœboid aspect.

Figs. 15 &16. The preceding amœboid zooid, having in the first instance assumed a quiescent or encysted state, and in the second become divided by cleavage into four spherical segment-masses or blastomeres.

Figs. 17 & 18. Two adult colony-spheres of *Magosphæra planula* developed in a moruloid manner from a continuation of the cleavage process of the preceding type, the first viewed superficially, and the second in optical section. In the latter instance the union of the separate zooids with one another by their slender posterior extremities is made manifest, the colony presenting under such conditions a close structural correspondence with the swarm-gemmule of the sponge, illustrated by figs. 10 & 11 of the preceding Plate. Both consist of similar unit-aggregations, the separate zooids in the case of *Magosphæra* having numerous terminal cilia, and in that of the sponge-gemmule a single cilium only. (Figs. 13–18 after Haeckel.)

Fig. 19. A separated sporocyst with spores from a calcareous sponge, *Leucosolenia botryoides*, Bow.

Fig. 20. An intraspicular area of *Leucosolenia botryoides*, consisting of a thin film-like expansion of structureless sarcode or syncytium, in which are immersed collar-bearing sponge-monads in an encysted state; these, as at *a*, are laden with spores, while, as at *b*, these spores have been liberated and scattered within the syncytium by the dissolution of the cell-wall of the encysted monads or sporocysts. These liberated spores gradually develop through an amœboid phase into typical collar-bearing monads, and fill up the intraspicular loculi, as shown in the succeeding figure. An exceedingly minute triradiate spicule is shown at *sp*, developing within the substance of the syncytium. × 600 diameters.

Fig. 21. A similar intraspicular area of the same sponge, in which the typical collar-bearing monads have increased to such an extent as to completely line it in a continuous pavement-like manner; the collars of the individual monads, so as not to interfere with the general view, are represented only along the upper margin, and as single instances in the two pores marked *p*.

Figs. 22–24. Spore-capsules or sporocysts of a siliceous sponge (*Halichondria*, sp.) derived from the encystment of the ordinary collar-bearing monads. At fig. 24 the sporocyst is bursting and setting free its countless granular spores.

Fig. 25. Spherical cluster of spore-like bodies from a species of *Hymeniacidon*. These are at first enclosed within a membranous sporocyst, and afterwards, falling asunder, become distributed throughout the substance of the syncytium. × 500 diemeters.

XVIII.—*Parasites of the Spongida.* By H. J. Carter, F.R.S. &c.

In 1871 ('Annals,' vol. viii. p. 330) I stated that I hoped soon to communicate an "illustrated paper on the parasites of sponges;" and now, after having examined all the specimens of the latter in the collections of the British Museum together with those belonging to the late Dr. Bowerbank, and with my own experience of the living sponges here (Budleigh-Salterton), I propose to notice those parasites which have come under my observation and of which I possess specimens, being well aware that there must be many more which have not been discovered, or, if discovered, have not been made public.

For illustrations I prefer figures which combine that of the sponge with that of the parasite; and therefore reference will be made to these whenever possible, while the rest hardly require any; so that the only illustration that I shall insert will be one of *Spongiophaga communis*, which will be given in a woodcut opposite the description.

Crustaceans.

It seems not uncommon for small Amphipod Crustaceans about 1-12th inch long to nestle in the surface of some sponges, where they make little oval depressions to lie in, more or less bent upon themselves, which depressions, in the absence of the crustaceans, may sometimes be taken for vents. This was first noticed in *Suberites antarcticus*, MS. (a branched Suberite of a grey colour, with large and almost spherical head to its pin-like spicules, dredged up by Sir J. Ross in 300 fathoms in 77½° south latitude), and the crustacean kindly described and illustrated by the Rev. R. R. Stebbing, M.A., under the provisional name of *Dexamine antarctica* ('Annals,' 1875, vol. xv. p. 184, pl. xv. fig. 1, &c.). Similar depressions with a smaller crustacean of a like form were afterwards observed on the surface of a large mouse-coloured, areniferous, estuarian variety of *Suberites domuncula*, Nardo, =*Halichondria suberea*, Johnston, on a *Buccinum* containing a *Pagurus*, probably from the Firth of Forth, Scotland, and, lastly, though of larger size, on a living specimen of *Halichondria incrustans* from this place (Budleigh-Salterton).

Crustaceans are commonly found in the cloaca and halfway through its aperture in *Grantia ciliata* and *G. compressa*, especially towards the maturity of the *gastrula*, which, being free from spicules and rich in nutriment, they devour greedily, not refusing portions of the sponge itself; so that, in gathering pieces of the seaweed on which *G. compressa* chiefly grows here, it is desirable to free the specimens as much as possible from the Alga, lest, under confinement, the crustaceans issue from their nests in the latter, where they dwell in great abundance, make an onslaught on the *Grantias*, and destroy the greater part of them.

Cirripedes.

The Balanoid Cirripedes, whose embryos are so abundant that they almost cover every thing on the rocks here, together with the rocks themselves, could hardly be expected to refuse the surface of the Spongida; and hence, perhaps, they are the most common parasites of all; for, with the exception of the fleshy sponges (*Carnosa*) and the calcareous ones (*Calcarea*), they make use of every other kind of sponge, becoming, as they increase in size, overgrown by the sponge itself, whether the latter is kerataceous or vitreous, so as to form wart-like excrescences with a hole in the summit for the projection of the cirri. The species appear to vary in the same as well as in different localities; and the term "*Acasta*" has been applied to the whole group by Leach.

Actinozoa or Polyps.

In all parts of the world sponges are more or less infested by polyps, chiefly on the surface, which may be single, double, concatenated, or grouped, isolated or aggregated, sunk to the level of the surface of the sponge which they may infest without scleroderma, or with it *in* the scleroderma *on* the surface of the sponge, or pendent from the scleroderma; and all belong to the Zoanthidæ = Palythoa, Lamour., = Zoantha of De Blainville.

Of those on the sponges of the Antilles, Duchassaing de Fontbressin states:—

"Les Zoanthes, les Mamillifères et les genres voisins sont littoraux; cependant il y a des exceptions pour quelques-uns des ces êtres, comme le *Zoanthus parasiticus*, le *Gemmaria Swiftii* et les *Bergia*, qui toutes sont parasites des éponges, et que j'ai recueillies par une profondeur variant entre 2 et 8 mètres. Ces espèces ne se trouvent jamais que fixées sur les Spongiaires; elles ne se rencontrent sur aucune autre espèce de corps marins." ('Revue des Zoophytes et des Spongiaires des Antilles,' par M. P. Duchass. de Fontbressin, 1870, p. 22.)

Such are the words of this naturalist, who, with M. (afterwards le Chevalier) G. Michelotti, published copiously illustrated works on the corals and sponges respectively of the Antilles and the Caribbean Sea, gathered by themselves alive and dead in these localities before the year 1864 ("Spongiaires de la Mer Caraïbe, par P. Duchass. de Fontbressin et G. Michelotti," Natuurk. Holland. Maat. Wet. te Harlem, 1864, vol. xxi. 4to).

The character of these polyps is to have their sclerodermic parts more or less charged with foreign bodies, viz. grains of sand and sponge-spicules entire and fragmentary, derived from the sponges of the locality generally, but chiefly from the sponge on which they may be situated. I can, of course, state nothing of the softer parts in their original condition, as my descriptions are taken from dried specimens; hence *this* information must be sought from other sources.

1. *Polyps single or isolated, scattered over the surface more or less generally, sunk to the level of the sponge, but marginated; about* 1-16 *inch in diameter.*

Especially observed in the genus *Tuba*, Duchass. de F. et Mich. (*op. cit.*, e. g. *T. digitalis*, pl. viii. f. 2), Rhaphidonemata, fam. Cavochalinida, groups 6–8, Cart. ("Notes Introductory to the Study of the Spongida," 'Annals,' vol. xvi. p. 141) = *Siphonochalina*, Sdt.; also in *Reniera fibulata*, Sdt. (Holorhaphidota, group 5. Fibulifera, Cart. *op. cit.* p. 178), from the seas between the Americas; also in *Axinella polypoides*, Sdt., from the Adriatic sea (Schmidt, Spong. Adriat. Meeres, Taf. vi. f. 4).

2. *Polyps single or concatenated, scattered over the surface more or less generally, sunk to the level of the sponge, but marginated; about the same size as the foregoing.*

See especially the genus *Thalysias*, D. de F. et M. (*op. cit.*), Holorhaphidota, group 3. Thalyosa, Cart. (*l. c.*). For a good figure see *Isodictya mirabilis*, Bk. (Proc. Zool. Soc. Lond. 1873, pl. xxviii. figs. 1, 6, 8), = *Thalysias subtriangularis*, D. de F. et M., 1864 (*op. cit.* pl. xvii. fig. 1), from the seas between the Americas. The name used by Dr. Bowerbank must be suppressed, as it was given long after that of D. de F. et M.; and that of "inhalant pocilla" applied by him to the polyps is a mistake, carried on from his description and figure of 1864 (Mon. Brit. Spong. vol. i. p. 278, pl. xx. f. 308). The description, however, faithfully illustrated by his artist Lens Aldous, records all that is necessary respecting the dried form of the polyp.

Should instances of circumscribed *inhalant* caliciform or tentaculiform areæ in sponges be desired, they may be found in *Grayella cyathophora* and *Cliona corallinoides* respectively, as represented in the 'Annals' (the former in 1869, vol. iv. pl. vii., and the latter in 1871, vol. viii. pl. ii.).

3. *Polyps single, double, concatenated or irregularly grouped; sunk into a scleroderma upon, but not into, the surface of the sponge; circumference of the polyp defined but not marginated, about* 1-12*th inch in diameter.*

See especially *Echinonema typicum*, Cart. MS. (Echinonemata, fam. Ectyonida, group 1. Pluriformia, *op. cit.* p. 143, &c.). From Freemantle, S.W. Australia. *Very* common on the branched digitate form.

4. *Polyps single, double, or irregularly grouped, more or less pendent from their scleroderma, situated upon the surface of the sponge; sometimes* 1-4*th inch long.*

Ex. gr. *Axinella damicornis*, Sdt., and *A. verrucosa*, Sdt. (Spong. Adriat. Meeres, Taf. vi. figs. 2 and 3 respectively, 1862). *Palythoa axinellæ* is Schmidt's name for this polyp, which is more pendent but smaller in the head than the following species, viz. *Palythoa fatua*, M. Schultze ('Hyalonemen,' 1860, S. 27, *ff*), which grows over the upper part of the glass cord of both *Hyalonema Sieboldii*, Gray, from Japan, and *H. lusitanicum*, Boc., from the Atlantic, on the coast of Spain and the north of Scotland. See *H. mirabilis*, Gray (Proc. Zool. Soc. Lond. 1857, =*H. Sieboldii*, Gray, 1835, *ib.*), partly copied into Dr. Bowerbank's 'Mon. Brit. Spong.' vol. i. p. 287, pl. xxxv. f. 374, where the polyps are considered by Dr. Bowerbank to be the "oscula" and *not* the "inhalant areæ" of the sponge, as stated and delineated in fig. 308, *ib.*, before mentioned! This somewhat ficoid species occurs on the depressed and sessile forms of *Tethea muricata*, var., Bk.,=*Normania crassa*, Bk. (Mon. Brit. Spong. vol. iii. 1870, pl. lxxxi. fig. 1), where there is a group of four figured *without indication*, on the right side of the median line close to the upper margin, which I recognize here, especially, because the same thing occurs on a similar specimen dredged up on board H.M.S. 'Porcupine' between the north of Scotland and the Färoe Islands.

With reference, however, to Duchassaing de Fontbressin's statement before quoted, viz. that the parasitic polyps of sponges to which he alludes do not occur on any other marine organisms, there is, in the British Museum, a flat, elliptical, sessile mass or colony of *Hydroid* podocorynid polyps about three inches long and one tenth of an inch thick, whose delicate, erect, colourless filaments in juxtaposition, like the hairs of a clothes-brush, rising from a tough matted mycelium, present an even surface of hydranths on the top sufficiently firm to support several patches of a parasitic polyp, to me identical with the *Palythoa fatua* of the glass cord in *Hyalonema Sieboldii* &c.

On the other hand they are present at such an early period in some sponges that at first it seems as if they were part of the sponge itself, or, at least, developed in combination with it. But when we reflect on the unerring certainty with which the pollen-grains of diœcious plants find their way to the stigma of the female flower *through the air*, and, indeed, the spermatozoa of the myriads of beings, both animal and vegetable, growing together on our shores, find their respective species amidst hosts of others on the same errand, *through the sea*, we cannot wonder that a similar instinct directs the parasitic Zoanthidæ in their embryonic state to find the objects on which they respectively prefer to dwell. At the same time, as these polyps are not seen on the sponge at a very early stage of development, nor are always present on the same species, it is evident that they are not a part of the sponge, nor developed *pari passu* with it; while it is equally evident that, in the *first* instance, they must have come from an unparasitic *Palythoa*, and therefore have obtained their specific differences subsequently, although, when once these have been obtained, they continue, from adaptation, to prefer their new habitat to that of the original stock. This, indeed, is the law of adaptation and inheritance.

Hydrozoa or Hydroid Polyps.

While in all cases of Actinozoic parasitism that have come to my notice in sponges the polyps have been *confined to the surface*, those of Hydrozoic parasitism have extended into *the deepest parts of the sponge*, and, in one instance, have been entirely confined to the interior.

Taking, first, those whose tubes opened on the surface—one was found by Dr. Allman in a "horny sponge on the southern shores of France" and called by its discoverer "*Stephanoscyphus mirabilis*" (Trans. Linn. Soc. 1875, ser. 2, vol. i. pt. i. tab. xiv.; and 'Nature,' 1874, July 30, p. 251); and the other in *Reniera fibulata*, Sdt., *Suberites flavus*, Liebkh., *Esperia Bauriana*, Sdt., and *Myxilla fascicularis*, Liebkh., respectively, by Prof. F. E. Schulze in the Adriatic Sea, who designated it *Spongicola fistularis* (Archiv f. mikroskop. Anat. 1877, Bd. xiii. p. 795, Taf. 45–47); while the instance in which the Hydrozoon was confined to the interior of the sponge occurred to myself, and was noticed in a specimen of *Reniera* (*R. polypifera*, Cart. MS.) from Bona

Bay on the north coast of Africa ('Annals,' 1872, vol. x. p. 50).

Of *Stephanoscyphus mirabilis* Dr. Allman states that it "may be found attached to stones in small patches of one of the horny sponges," of which the figure in the Trans. Linn. Soc. (*l. c.*), being of the "natural size," is about two inches in diameter and half an inch thick in the middle. This consisted of a "congeries of tubes which penetrate the sponge-tissue and open on its surface," being, with their contents, "united by a common tubular plexus towards the base of the sponge" ('Nature,' *l. c.*).

On the other hand, *Spongicola fistularis* is stated by Dr. Schulze to consist of a series of branched tubes (*l. c.* Taf. xlvii. fig. 8), opening on the surface of the sponge by one end (Taf. lxv. fig. 1), and closed or blind at the other. Hence *Stephanoscyphus mirabilis* not only differed from *Spongicola fistularis* in this way, but the former being in a "horny sponge" seems to intimate, although the kind is not mentioned, that it was in a totally different order from all those bearing the hydrozoon so elaborately described and beautifully illustrated by Dr. Schulze.

In my own case, where the polyps were situated in the interior of the sponge, I have nothing to add beyond what has already been stated, 'Annals,' *l. c.* (for the specimen was returned, with all the rest of the sponges dredged up on board H.M.S. 'Porcupine,' to Sir Wyville Thomson last year, 'Annals,' vol. xix. p. 432), viz. that "the minute delicate polyps were seated in dilated cavities, apparently of the excretory canals, the disk or head of each polyp averaging 1-100th inch in diameter, and supported on a short neck, which ended in a little saccular prolongation that was sunk into the parenchyma or sarcode of the sponge, and charged in its walls, as well as in its tentacles, with thread-cells, &c." But that my object then was chiefly to show that the thread-cells observed by Eimer in *Reniera fibulata* and *Desmacella vagabunda*, Sdt., probably did not belong to the sponge, as subsequently confirmed by Schulze's observations (*l.c.* p. 799), I should probably have paid more attention to the structure of the polyp itself, which, however, from its minuteness, position, and exserted tentacles, might be inferred to have been a Hydroid rather than an Actinozoid polyp like that of *Palythoa.*

Algoid Parasites.

Seaweeds.

It is not an uncommon occurrence in some parts of the world for a seaweed to become a pseudomorph of a sponge (to use a mineralogical term), in which the latter, like a "dissolving view," may be observed (through different specimens) to yield gradually to the former, so that, at last, the seaweed not only assumes the shape of the sponge generally, but that of the form and position of the vents and every other part of the sponge saving the spicules, or foreign bodies of a like nature, which thus are often the only remaining evidence of the *kind* of sponge that has thus been pseudomorphosed.

I noticed this first in specimens of *Reniera fibulata*, Sdt., from Hong Kong, in the British Museum, wherein parts of the sponge itself still remained to prove what has been just stated; and since then several specimens have been added from the late Dr. Bowerbank's collection, that were obtained from Freemantle on the south-west coast of Australia—which led me to seek for the seaweed in Harvey's 'Phycologia Australica,' where I found it figured under the name of "*Thamnoclonium flabelliforme*," also from Freemantle (vol. ii. pl. 13).

The fan-shaped pseudomorphs in the British Museum represent the figure, and bear remains of the spiculation of this form of *Echinonema typicum*, Cart. MS., which is very common at Freemantle; another, that of a Suberite with pin-like spicules only (that is, without any flesh-spicules); and a third bears on its surface portions of the reticulated incrustation of foreign bodies characterizing many of the Psammonematous sponges.

Frequently, as stated by Harvey, on the more prominent parts of this parasitic seaweed may be observed little pedicelled leaf-like expansions or young fronds, which, when softened by soaking in water, present "tetraspores lodged in discoid nemathecia, in their substance;" and thus far the reproductive elements of this Alga have been discovered.

Red Alga parasitic in Halichondria plumosa, *Johnston.*

There is an amorphous Alga (apparently undescribed) which infests some specimens of *Halichondria plumosa* on this coast, consisting of a pseudofrondaceous expansion of carmine-red cells, which, pursuing in its growth the main branches of the skeleton, from the base to their termination on the surface of the sponge, finally produce a dark-brown-coloured, equally amorphous, wart-like fructification.

Its cells are irregularly globular, of a beautiful carmine colour, and held together by a gelatinous membrane, which not only grows upwards round the axis of the branches mentioned, but extends outwards laterally for some distance over the echinating spicules of which they are respectively chiefly composed, finally ending on the surface in a clathrate structure, which throws out small, irregular, wart-like, botryoidal masses of a black-brown colour (in sizes below 1-36th inch in diameter). The latter are composed of a crust formed of radiating columns of brown cells in juxtaposition (each column consisting of a transparent theca enclosing about a dozen), containing, or accompanied by, or both, globular tufts of branched short filaments of *red* cells mixed with paraphyses, the filaments being clavate from the enlargement of the cells towards the free ends, thus becoming terminally (?) sporiferous, much like those of *Hypoglossum Woodwardii* figured by Payer (Botan. Cryptogamique, 1850, p. 47, fig. 209). No tetraspores could be recognized; but where the pseudofrondaceous layer had left the sponge and spread itself over surrounding *Balanus*-shells, it presented somewhat the appearance of *Hildenbrandtia sanguinea.*

The red cells of the thallus are about 1-4000th inch in diameter, and the brown cells of the columns about a third smaller, while the terminal cells of the branched filaments in the "tufts" are the largest of all. The brown warty fructification (? nemathecia) is surrounded by a transparent membranous envelope; but this, as well as all the other structures that I have mentioned, can only be seen under the microscope in a fresh state, or on soaking in water, after having become dry. The red colouring-matter of the cells is not affected by drying, nor is it much altered by the addition of liquor potassæ.

As this Alga appears to be unnamed and undescribed, this can be best done by those who have given their attention especially to the subject.

Oscillatoria.

There is a Suberite with pin-like spicule only (that is, without flesh-spicule), which occurs on the rocks here a little above low-water mark, in small thin patches about half an inch in diameter, of a beautiful cobalt-blue colour; and when examined with a microscope the blue colour is found to be owing to the presence of innumerable short separate filaments of an Oscillatorian alga, which, answering to the description of the genus *Hypheothrix*, Kg., but with blue granules, from which the cobalt-blue colour of the sponge is derived, might be called "*H. cærulea.*" The filaments vary in length under 1-1500th inch, with a diameter of 1-12000th inch; and the colour fades much on drying, but does not altogether disappear.

Scytonema.

A species of this Alga with its germinating gonidia still retaining their dark yellowish-green colour, is abundant in a specimen of *Spongia otahetica* in the British Museum, about which there are no remains of sarcode; so that it was probably after the death of the sponge that this Alga took up its abode there. It is therefore only mentioned here to show that, in describing the parasites of sponges, the circumstances under which they occur should not be forgotten; otherwise much more may be set down than really belongs to such parasitism.

There are also destructive organisms which not only attack the horny parts of the skeleton but the spicules themselves of a sponge after death, such as have been described and figured in the 'Annals' for 1873 (vol. xii. p. 457, pl. xvi. figs. 8, 9).

Palmella spongiarum, Cart.

In two instances I have found at this place sponges which have been rendered pink by the presence of a little spherical cell in great abundance, about the size of the human blood-globule,—viz. one in a specimen of *Halichondria panicea*, and the other in a specimen of *Cliona celata*. And on examining it with a microscope, I find that one mode of reproduction is by duplicate division, and that it is enveloped in a mucilage, which, as the *Palmella* grows and the cells become multiplied, thus extends itself throughout the sponge, and, by the immense number of its cells, produces the pink colour. The colour fades to a certain extent, but not altogether, on drying, and is changed to green on the addition of liquor potassæ, when it becomes very like a green *Protococcus*. While retaining the pink colour, it has very much the appearance, under the microscope, of *P. nivalis*, but is much smaller. It averages 1-2400th inch in diameter; and, not being polymorphic (that is, not being able to change its spherical form), it cannot be confounded with the ovules of the sponge, especially when of this size.

? SAPROLEGNIEÆ.

Spongiophaga communis, Cart. 1871.

This is a minute, short, nematoid filament, with a bulb at each end, which, multiplying to an enormous extent, especially in the *Hirciniæ* (Hirciniosa, 3rd Group, 'Annals,' *l. c.* p. 136), may, like the seaweed *Thamnoclonium flabelliforme*, become a pseudomorph of the sponge it attacks, so as to be mistaken for the sponge itself, as will presently appear.

In 1859 (Archiv f. Anat. u. Phys. Heft iii. p. 369, pl. x. fig. 2), Lieberkühn considered this filament to be a character of certain *Hirciniæ*, which he called "Filifera;" and in 1862, Schmidt (Spong. Adriat. Meeres, p. 30) accepted the character and proposed for the genus the following diagnosis:—

> "Ceraospongiæ duplici fibrarum genere præditæ, uno crassiorum, quæ inter se cohærentes sceletum proprie formant, altero subtilissimarum, quæ ex illis provenientes minutissimis capitulis terminantur et inter se non implicantur."

According to Schmidt (*op. et loc. cit.*), it was observed by Esper, who likened it to "wool;" but neither Esper nor Nardo made it a "character" of *Hircinia*.

In 1845 ('Annals,' vol. xvi. p. 407, pl. xiv. figs. 1–5) Dr. Bowerbank represented it as a "most remarkable character" in his genus *Stemmatumenia*; and in 1864, Duchassaing de Fontbressin and G. Michelotti partly founded their genus "*Polytherses*" upon this parasite, which they describe as "moniliforme," and figure with transverse *septa*, like the filament of an *Oscillatorium* ("Spongiaires de la Mer Caraïbe," *l. c.* pl. i. F, and pl. xii. fig. 5, &c. species).

In 1871 ('Annals,' vol. viii. p. 330) I stated that this filament was an Alga, and probably an *Oscillatorium*, which, from its frequently infesting sponges of different kinds in all quarters of the globe, I proposed to name "*Spongiophaga communis*;" further, it was then stated that "Schmidt (1862, Spong. Adriat. Meeres, and especially with figures in 1864, 1st supplement), after having given a great deal of attention to these filaments, which have a cell at one end and a spiral twist throughout, admits that they are different from the sponge-cell *par excellence* (*i. e.* the sponge-animal), and, after alluding to Kölliker's doubt in 1866, viz. whether it be a part of the sponge or a parasite, agrees in 1870 (Atlantisch. Spongienf.) with Kölliker, that the two structures, viz. the sponge-fibre and the fibrillæ, are different, finally ending with the expression that, after much trouble, he can state nothing further respecting the nature of the latter."

To this may be added Schmidt's opinion in 1878, at least, in a paper entitled "Die Fibrillen der Spongiengattung, Filifera, Lkhn.," of which he kindly sent me a copy in May last, viz. "Meine Angabe, dass die Fibrillen von Hornfasern entspringen, beruhte auf Täuschung" (pp. 661–2), and, further on, that all attempts to get out an "entire" fibril fail. But it will presently be seen, in the special description of *Spongiophaga communis* which I am about to give, that this has been accomplished, although probably owing to the specimen being more favourable for the purpose than any possessed by Dr. Schmidt.

Figures of the filament, so far as it was known, have been given respectively by Lieberkühn, Bowerbank, Schmidt, and, lastly, by Duchassaing de Fontbressin and Michelotti, whose "moniliform" or septate character, before noticed, partly led me to the idea that it was a species of *Oscillatorium*, which further investigation has not confirmed.

As before stated, this parasite chiefly, but not exclusively, attacks the *Hirciniæ* in all quarters of the globe, but becomes most remarkable when it has *entirely* replaced the sarcode in those great bowl-shaped specimens that come from the seas between the two Americas and from the southern coast of Australia respectively. The specimen represented by Duchassaing and Michelot (*l. c.*), viz. *Polytherses campana*, is not an uncommon form, wherein the "bowl" has not been completed; while there are large massive forms also of this species of *Hircinia*, and some from the neighbourhood of Cuba, which present *no* filament; but, lest it should be fancied that these might have belonged to a different species and *therefore* not to possess the filament, it might be stated that in the British Museum there are some "bowl-shaped" ones from Australia which present nothing but the original sarcode, and others nothing but the filament respectively covering their skeletons, which thus, in each instance, retain the "bowl-shaped" form of the original sponge.

Besides this, it is abundant in a specimen of *Axinella faveolaria*, Sdt. (mihi), three feet long, which came from the Levant, and was presented to the British Museum by Admiral Spratt, also in several specimens of *Reniera fibulata*, Sdt., *Esperia*, &c., and in one instance even *in the excavated chambers* of a *Cliona* in an old piece of stony coral from Cuba, where it is mixed up with the pin-like spicules of the species, which may be seen together with it in the mounted preparation.

I have not yet observed it in any of the Rhaphidonemata—although, on the other hand, the Cavochalinida, ex. gr. *Tuba* (Duch. de F. et M.), which also chiefly come from the seas between the Americas, are, as before stated, commonly infested by the "isolated sunken polyp" or *Palythoa*.

Then, again, although it is prevalent in several kinds of the Psammonemata besides *Hircinia*, it seems to have almost an antipathy to the officinal sponge, in the midst of which it may be seen to polymorphose the whole of the *Hircinia* (when the two have thus grown together), without sending a single filament into the *officinal sponge.*

After these statements it need hardly be added that the filament is a parasite affecting many kinds of sponges, and that therefore it cannot form a specific character of any. It will now be described, then, as such, in the *mass* or *tissue* and in the *element* respectively, under the name proposed for it in 1871, viz. :—

Spongiophaga communis, Cart.
(See figure.)

Tissue, when fresh, soft, flexible, gelatinous; when dry, papyraceous, tough, and when torn, in this state, tomentose. Composed of fibrillæ replacing partly or entirely the sarcode of various kinds of sponges, chiefly the Hircinida. Fibril about one third of an inch long, composed of a fusiform filament terminated at each end by a bulbous inflation which is similar; filament $1\frac{1}{2}$-6000th inch broad in the centre, diminishing gradually on both sides to half this diameter at the extremities; bulbous inflation more or less ovoid with the narrow end towards the filament, averaging 2 by $1\frac{1}{3}$-6000th inch in its greatest diameters; filament consisting of a transparent sheath filled with a gelatinous colourless substance in which no structure is visible until solution of iodine in hydriodate of potass is applied, when it becomes of an amber colour, assumes a spiral form, and the whole filament, if doubled upon itself, becomes rapidly intertwisted like the strands of a rope, returning to its natural state both outwardly and inwardly when the solution of iodine is washed out with water, so as to reassume its original appearance in every way. Internal contents

Spongiophaga communis
(artificially arranged).

Scale about 1-24th to 1-1800th inch.

slightly issuing from the broken ends of a divided filament, where they contrast strongly with the colourless state of the sheath under the application of the iodine solution; sheath circularly corrugated from retraction at this part, and presenting lines of corrugation on the *inner* side of a bend, but *no septa internally.* Contents of the bulb apparently the same as those of the sheath, with the addition of an indistinct nuclear body surrounded by a granular plasma, presenting a vacuole in the centre, but very variable in appearance in these respects, becoming of an amber colour under the effect of iodine, not purple like that of potato-starch &c. Filament sometimes swollen in the larger part by a nuclear body like that of the bulb, and, in like manner, often slightly accuminate at one point. When dry, highly hygrometric, twisting about on the field of the microscope on being breathed upon, like the elaters of an *Equisetum*-spore similarly circumstanced.

Hab. Marine. Infesting and destroying the sarcode of many kinds of sponges, especially the *Hirciniæ.*

Loc. Worldwide.

Obs. This parasite is not a commensalist, but a devourer of its host, like the seaweed *Thamnoclonium flabelliforme*—finally, in the Hircinida, replacing the entire sarcode so as (as before stated) to present a pseudomorph *only* of these sponges. Sometimes a few fibrillæ are a little thinner than the others in the rest of the mass; and in some sponges they are altogether thinner than in others, as in *Sarcotragus spinulosus*, Sdt., where they are *all* thinner than in *Hircinia variabilis*, Sdt., as seen in the type specimens of these sponges respectively in the British Museum; but this is the only difference that I have observed in them worth noticing in a developmental point of view. The bulb often varies slightly in shape; and the filament appears to be sometimes *once* branched; but in what form the branch terminates I am not able to state, having only observed it once; besides, these varieties can only be viewed as anomalies. Under no circumstances have I been able to satisfy myself that the contents of the filament are septate. As with the smaller, coreless, horny sponge-fibre, so with this filament, decomposition of the contents of the interior leads to the formation of oleaginous globules, which, presenting shades of colour varying from ochraceous yellow to rusty red, cause the tissue formed by them to present these colours respectively.

Although dyeing with magenta and mounting some of the filaments of a specimen that I possess which has been preserved in spirit has given the *entire* form, nothing that I have yet seen has led me to a knowledge of the mode of reproduction and development; nor have I ever noticed any more decided difference in the size of the filaments than that mentioned. The whole of this part remains for future observation to determine; and it appears to me that such information can only be obtained from *living* specimens.

The filament resembles *Vaucheria* in its contents being continuous and not septate. *Vaucheria* also presents a faint resemblance to it in the terminal enlargements of its filament, which here are for reproductive purposes; but there is no chlorophyl in *Spongiophaga communis*, and in no other respect is it like *Vaucheria*.

There is an entophytic Saprolegnious cell (? *Pythium*, Pringsheim) which bores its way through the sheath of *Spirogyra*, especially under conjugation of the latter, and, entering the sporangium by tubulation, again becomes inflated there, nourishing itself with the contents of the sporangium, and finally producing a young brood in the inner cell or inflation, which may escape into the sporangium itself—or in the outer inflation, where the embryos may escape into the water—probably in these respects being influenced by the best prospect of support. Here, of course, there is no chlorophyl, and there are no septa in the tubulation, while the contents, until they become differentiated into a new brood, appear to be composed of structureless transparent plasma, presenting throughout nothing but an amber colour on the application of iodine.

How far *Spongiophaga communis* may be allied to the Saprolegnieæ I am not able to state; while its habits so far resemble those of *Thamnoclonium flabelliforme* as to produce in some *Hirciniæ*, as before stated, a pseudomorph of the sponge, in which hardly any thing more remains than the foreign objects which formed the core or axis of the horny fibre.

Saprolegnious Mycelium.

In 1845 ('Annals,' vol. xvi. p. 405, pl. xiii. figs. 1–6) Dr. Bowerbank described a new genus of sponges under the name of "*Auliskia*," which was characterized by the presence of "minute cæcoid canals radiating from the fibre in every direction." These, however, Schmidt, in his critique on the synonyms and species of the Keratospongia (Spong. Adriat. Meeres, 1866, 2nd Suppl. p. 10), considered algoid, and therefore rightly observed that the genus should be suppressed. I had also observed it in two or three instances, and had regarded it in the same light—that is, of the same nature as the tortuous, branched, tubular filament which sooner or later infests almost every hard marine organization, both kerataceous and calcareous. How far it may occur after death I am not able to state; but it is present in the fibre of *Aplysina capensis*, Cart. MS. ('Annals,' 1875, vol. xvi. p. 192)—that is, a reddish, purple, massive hircinoid *pseudoceratinal* sponge from Algoa Bay, which, from the presence of the sarcode, appears to have been living when taken up for preservation.

Thus Dr. Bowerbank's genera respectively, viz. "*Stemmatumenia*" and "*Auliskia*" were founded on the presence of a parasite, and that following, viz. "*Cartilospongia*" (*ib.* p. 408, pl. xiv. figs. 6–8), upon the structure of a compressed, circular, cake-shaped piece of bone! Curiously enough, in examining Dr. Bowerbank's collection, the identical bone has come before me, which appears to be the body of a *fœtal* whale's vertebra, bearing the exact dimensions and descriptive characters given by Dr. Bowerbank (*l. c.*). At first sight it is very much like the skeleton of a sponge of this shape; but the odour evolved by making a vertical section of it through the short axis, and the microscopic examination, place beyond a doubt its true nature. As Dr. Bowerbank was a good observer, his description and illustrations are valuable from their correctness; but his inference was incorrect.

Foreign Objects.

Although these, being without life before they were taken up by the sponge, cannot be considered parasites, yet there is one which so frequently occurs in the Psammonemata, so like a mineral product, and often so abundantly, that it demands a passing observation here. I allude to a little prism of *calcite* banded occasionally with yellow, brown, red, or amethystine colours, separately or more or less united in the same prism. It occurs in these sponges generally, but most plentifully in the Arenosa from Port Jackson; and hence I thought at first that it must come from some mineral source there; however, one day finding groups of these prisms *in situ* in a large specimen of an *Esperia* from Southern Australia, which had also enclosed some bivalve shells like *Crenatula phasianoptera*, I was led to compare them with the structure of the latter, and immediately saw that, everywhere, their source must be from the disintegration of thin shells like this, which are made up of similar prisms, coloured in accordance with the shells from which they are derived.

Dendrites.

Very often, on old kerataceous fibre, little, colourless, circular dentritic spots make their appearance whose structure is so minute that even under a compound power of $\frac{1}{4}$ inch with high ocular it does not appear satisfactorily. All that can at present be stated of them is, that they are composed of branched filaments which radiate from a central point; but whether they are algoid or fungoid, or what their real nature is, future observation must determine.

Rot.

Lately several complaints have been made of the rapid washing away of officinal sponges after they have begun to be used; and on microscopical examination of such sponges before and after they have been brought into use, it would appear that while the superficial fibre is all continuous, that within is broken up into short pieces. How and when this occurs I am unable to state, further than that, like dried fish not properly cured, the surface may remain good while the interior becomes broken down by putrefaction; or it may be from some chemical substance used in preparing them for sale, which has not been thoroughly washed out from the interior; but the surface remaining sound in each instance would ensure their sale until the unfortuate purchaser finds out that, after a little usage, they become reduced to nothing, and that the soundness was merely superficial. Perhaps the best test of a sound sponge is the extent to which it expands, and *vice versâ*, after having been filled with water. Those which are broken down in the interior, not having the same amount of resiliency as the rest, will probably vary little in size by the change. (For an excellent account, with illustration, of the mode in which the officinal sponge is obtained in the Levant, see 'Travels and Researches in Crete,' by Captain (now Admiral) T. A. B. Spratt, R.N., C.B., F.R.S., &c., vol. i. chap. xx. p. 215, 1865: Van Voorst.)

XIX.—*Measurements of the Red Blood-corpuscles of the American Manatee* (Manatus americanus) *and* Beluga leucas. By George Gulliver, B.A., Pemb. Coll. Oxon.

Through the kindness of Mr. Carrington I have been enabled to examine the blood of the American Manatee now in the Royal Aquarium, and have made careful measurements and comparisons of the red corpuscles.

In a paper by my father "On the Sizes and Shapes of the Red Corpuscles of the Blood of Vertebrates," published in the 'Proceedings of the Zoological Society,' June 15, 1875, there occurs the following remark :—" Much larger red blood-corpuscles than those of the human species may be expected in the most gigantic marine Feræ and Cetacea. The largeness of the corpuscles in *Orycteropus* was truly predicted long before they were ever examined; and we may well suppose that they were larger in the huge extinct Edentates than in any existing mammal. It would be interesting and probably instructive to examine the corpuscles of the Sirenia."

Some time back, in a communication to my father, Prof. Garrod stated that he had examined the blood of the individual of this species which died in the Zoological Gardens, and found the corpuscles to be of large size. He has since published measurements of the corpuscles in the Zoological Society's 'Transactions' for Oct. 1, 1877, where he says, " In the Manatee the diameter of the largest corpuscles reaches $\frac{1}{2700}$ of an inch, others being considerably smaller." As an independent confirmation of his observation that the corpuscles of this animal are of a large size, and at the same time an expression of opinion on my father's and my own part that they are considerably larger than he supposes, I venture to think that this observation is not without value.

I have submitted a specimen of the blood to my father, who agrees with me in making the average size of the corpuscles $\frac{1}{2400}$ of an English inch. It is well known that in the same species, and in the same individual of that species, the red corpuscles are found to vary within certain limits; and it is only by careful and constantly repeated observations that the prevailing or mean size can be estimated. It is this size only which is given here.

Whilst I was watching the dissection of the white whale (*Beluga leucas*) which recently died in the aquarium, Dr. Murie was kind enough to provide me with specimens of the blood. Knowing, from my father's measurements of the corpuscles in other species of Cetacea, that they would prove to be large in this animal, it was interesting to obtain a specimen of the blood for comparison with that of the Manatee. It requires more than a superficial glance to detect a difference in size in the red corpuscles of the two animals. But in the *Beluga*, though the corpuscles are, without doubt, superior in size to those of any of the three cetaceans mentioned by my father, they are decidedly inferior to those of the Manatee. Their average diameter is $\frac{1}{2650}$ inch. The corpuscles of this cetacean, then, rank next in size amongst Mammalia to those of *Manatus americanus*, those of the other Sirenia being, in all probability, also superior in size.

Though, perhaps, the size of the red corpuscles cannot, in our present imperfect state of knowledge, be said to throw much light on the affinities of the Sirenia, it would be nevertheless interesting to be able to add to the characters of the group that they possess very large red corpuscles, in all probability exceeding in size those of any other group of Mammalia.

XX.—*Note on* Tethea muricata, *Bowerbank*. By H. J. Carter, F.R.S. &c.

During the examination of the late Dr. Bowerbank's collection of sponges, now the property of the British Museum, I found the type specimen of his "*Tethea muricata*," and only noticing at the time that it was identical with *Wyvillethomsonia Wallichii*, Wright, merely attached this name to it.

Just now, however, I have received a little Arctic sponge from my old friend Dr. Dickie (late Prof. of Botany in the College at Aberdeen), with the following label, viz. "Lat. 75° 15′ N., and long. 13° W."—that is, from the Greenland Sea,—and another by Dr. Bowerbank, to whom it had been submitted, viz. "*Tethea muricata*, Bow., MS. The type specimen is from Vigten Island, Norway, by Mr. M'Andrew."

Thus it struck me, when recognizing that it also was a specimen of *Wyvillethomsonia Wallichii* and the same as the type specimen *T. muricata*, which the late Mr. M'Andrew had obtained by dredging off Vigten Island, that the latter might have the priority in nomenclature; so I referred to Dr. Bowerbank's description and illustration of *Tethea muricata* (Proc. Zool. Soc. 1872, p. 115, pl. v. figs. 1–6), and there found that Mr. M'Andrew had presented it to Dr. Bowerbank in 1855, and that the latter had named and figured part of it in the 'Philosophical Transactions' for 1858, pl. 25. fig. 18, and again in 1862, pl. 31. figs. 14, 15. Further on in the description, viz. at page 117, Dr. Bowerbank states that Mr. Kent had described a "specimen of the same species" in the 'Monthly Microscopic Journal,' 1870, p. 293, under the designation of "*Dorvillia agariciformis*."

Under the name of "*Wyvillethomsonia Wallichii*" it was described and figured, from a very young specimen, by Dr. E. Perceval Wright (Quart. Journ. Microsc. Sci. January 1870, p. 7, pl. 11); but Mr. Kent's specimen, being older and much larger, affords by far the best typical form and detail (for scores of them of all sizes came under my view while describing the sponges dredged up on board H.M.S. 'Porcupine').

Schmidt notices a specimen "with the plates" sent to him by Sir Wyville Thomson in May 1870 (Atlantisch. Spongienf. p. 68); and seeing that it was closely allied to his *Stelletta*, it was added to the list of his "Anchorinidæ" (*ib.* p. 80), under the name of "*Stelletta*" (*Tisiphonia*) *agariciformis*, the latter, viz. *Tisiphonia agariciformis*, being Sir Wyville Thomson's appellation.

It is strange that Schmidt in 1877 (Archiv f. mikroskop. Anat. Bd. xiv. p. 260) should even "provisionally" call another specimen of this sponge "*Stelletta echinoides*," which he obtained from the Bay of Naples.

However, we now know that "*Tethea muricata*, Bowerbank," has the priority of all these names, while it does not detract from the merit of Dr. Wallich, who dredged up the little specimen described by Dr. Wright, on board H.M.S. 'Bulldog,' as far back as 1860.

Tethea cranium, Johnston, has been made the type of my Tethyina, the 16th group of the order Holorhaphidota, in the 3rd family, viz. Pachytragida ("Notes Introductory to the Study and Classification of the Spongida," 'Annals,' 1875, vol. xvi.); so *Tethea muricata*, according to its generic designation, would come in here, where, at p. 198, a list of all the known species is given, with the exception of *Tethea antarctica*, dredged up by Sir J. Ross in 300 fms., $77\frac{1}{2}°$ S. ('Annals,' 1872, vol. ix. p. 412, pl. xx.), and *T. zetlandica* (*ib.* p. 417, pl. xxii. fig. 2), the former of which differs from all the rest in having no bihamate flesh-spicule (as confirmed by another specimen from the neighbourhood of Kerguelen Island); and the latter, viz. *T. zetlandica*, I now find to differ hardly in more than varietal characters.

But *Tethea muricata*, = *Stelletta agariciformis* (*l. c.*), certainly, as Schmidt has intimated, agrees more with his *Stelletta* than with any other known sponge. In the length of its anchoring-spicules, however, it is more like *Tetilla polyura*, Sdt. (Atlantisch. Spongienf. Taf. vi. fig. 8), and *Tethya dactyloidea*, C. ('Annals,' 1872, vol. ix. pl. x. fig. 1), which causes it in this respect to approach the bearded Hexactinellidæ, whose anchoring-spicules again seem to have their length influenced by their usual habitat on the subtle mud of the deep-sea bottom, as the fragment of *Euplectella aspergillum*, which was dredged up on board H.M.S. 'Porcupine,' had no anchoring-spicules at all, its base being directly attached to a branch of *Lophohelia prolifera* ('Annals,' 1876, vol. xviii. p. 472). So also *Tethea muricata* may be influenced in this respect under similar circumstances, as will presently appear.

The long tails (in plurality) of bifid, recurved anchoring-spicules, the long-shafted trifid and once bifurcate "zone-spicules" of the body, the long and smooth acerates, the smaller acerates more or less microspined and more or less inflated in the middle, together with the elongated, subspiral, stellate flesh-spicule, characterize *Tethea muricata*, but nothing more than the lace-like, clathrate sarcode densely charged with this peculiar flesh-spicule, which especially hangs about the body just under the margin of the agariciform head, where the sponge has this form, and in the body generally of the other specimens. It was therefore (as will be seen by a reference to Dr. Bowerbank's illustrations, *l. c.*) this part in particular which he selected for that purpose, which, being peculiar to *Tethea muricata*, at once serves to identify the latter with *Wyvillethomsonia Wallichii*, even if he had not done so himself through *Dorvillia agariciformis* (*l. c.*).

Further, it may be observed that, the type specimen of Dr. Bowerbank's *Normania crassa* (Mon. Brit. Spong. vol. iii. 1874, p. 257 &c., pl. lxxxi.) is only a sessile form of *Tethea muricata*, in every respect similar to one which was dredged up on board H.M.S. 'Porcupine.' Both, like the fragment of *Euplectella aspergillum* to which I have above alluded, were without anchoring-spicules; and each possessed a parasitic *Palythoa* on its surface, like that on the glass cord of *Hyalonema* (see pl. lxxxi. upper margin right side, *l. c.*); so it is not improbable that both, coming from the neighbourhood of the Shetland Islands, may have grown upon hard objects respectively, and not on the subtle mud of the deep-sea bottom. Lastly, the type specimen of Dr. Bowerbank's *Hymeniacidon placentula* (*op. cit.* pp. 189 and 353, pl. lxxii.), a species obtained respectively from the Hebrides and the Shetland Islands, is also a similar variety of *Tethea muricata*, which seems from its compressed form to have been dried under pressure.

Although, however, this must lead to the suppression also of the names "*Normania crassa*" and "*Hymeniacidon placentula*" (which, together with the sessile specimen dredged up on board the 'Porcupine,' came from the Atlantic Ocean, between the north of Scotland and the Färoe Islands), yet it shows, with what has gone before, that *Tethea muricata* is equally present off the coast of Norway, off the east coast of Greenland, and in the Bay of Naples, together probably with the North-Atlantic sea-bed generally, where Dr. Wallich's specimens were obtained from the depth of "1913" fathoms. Next to *Tethea cranium* it was the most numerous of all the sponges dredged up on board the 'Porcupine;' and hence my observations on its extreme prolificness ('Annals,' 1876, vol. xviii. p. 405) under the name of *Tisiphonia agariciformis*, Wy. Thomson, 1870, =*Tethea muricata*, Bowerbank, 1858. Perhaps the sessile varieties might be termed "*crassa*, Bk."

XXI.—*Descriptions of several new Species of Lepidoptera in the Collection of the British Museum.* By ARTHUR G. BUTLER, F.L.S. &c.

RHOPALOCERA.

PANOPEA, Hübner.

Panopea expansa, n. sp.

Wings above smoky brown with black veins: primaries with a broad central oblique patch (cut into six divisions by the nervures), a subcostal spot halfway between it and apex, below which are two or three longitudinal streaks followed by seven submarginal spots, all subhyaline pearly white; a bifid internal patch and a spot at apex opaque white: secondaries crossed by a broad central band of subhyaline pearly white; its outer edge dentated through the incursion of the black internervular folds; a submarginal series of white spots, followed by a marginal series of orange spots: body black, thorax white-dotted. Primaries below paler, whitish at base: secondaries with the base yellowish and marked by seven black spots; external area pale bronzy brown, with the submarginal white spots much larger than above; no orange spots; palpi white with black tips; pectus black, spotted with white; abdomen testaceous. Expanse of wings 3 inches 1 line.

Masasi, East Africa.

This species is most nearly allied to *P. protracta*; but the broad patch or band of primaries renders it a link between that group and *P. mima*; the marginal orange spots of the secondaries are peculiar.

NEPTIS, Fabricius.

Neptis trigonophora, n. sp.

Allied to *N. melicerta*, but with the broad bifid discoidal patch of primaries replaced by a small triangular or cuneiform spot towards the end of the cell; the small internal spot replaced by a broad patch continuous with the broad central white belt of secondaries; the trifid subapical patch less distinctly divided into spots, and the bifid discal patch larger. Expanse of wings 2 inches 1 line.

Masasi, East Africa.

Also allied to *N. nicoteles.*

TERACOLUS, Swainson.

Teracolus catachrysops, n. sp.

Upper surface intermediate between *T. vesta* and *T. amelia*, the basal area being white, which changes to pale salmon-colour just before the middle of the wings; the base grey, less suffused than in *T. vesta*, but more than in *T. amelia*, the spots upon the broad border equal in size on the primaries to those of *T. amelia*, but larger on the secondaries, where those of the female are almost pure white; discocellular spot of primaries smaller than in *T. vesta*, but larger than in *T. amelia*. Primaries below bright golden orange, with markings nearly as in *T. vesta*: secondaries dull sulphur-yellow, with the markings of *T. amelia*, the bands, however, being dull red-brown, and the veins flesh-coloured. Expanse of wings, ♂ 1 inch 11 lines, ♀ 2 inches 1 line.

Masasi, East Africa.

Another of the interesting links in this beautiful group of butterflies.

HETEROCERA.

CRINODES, Hübner.

Crinodes Ritsemæ, n. sp.

Nearly allied to *C. Beschei* of Brazil, but considerably darker and more satiny; the primaries greyish brown with the dark markings deep greyish olive, becoming almost black upon the inner margin: secondaries sordid whity brown, with smoky brown submarginal belt. Body corresponding in colour with the wings. Expanse of wings 3 inches 2 lines.

Sapucaia Oroca, Rio Madeira (*Dr. Trail*).

Owing to Walker having placed this genus and one or two other groups of Notodontids amongst the Noctuites, I omitted them from my recent list of Bombyces of the Amazons. I have named the present species after the worthy Curator of the Leyden Museum, who has paid some attention to the genus.

Symmerista, Hübner.

Symmerista amazonica, n. sp.

Primaries above white, speckled with rust-red; some of the scales forming lines as follows:—an oblique irregularly zigzag line limiting the basal area, which is heavily speckled; two dentate sinuate double lines across the disk; a submarginal incomplete series of convergent blackish dashes, and a few blackish scales on the fringe: secondaries pale greyish whity brown with sordid white fringe: body whitish. Undersurface white, the veins and the costal area of primaries brownish. Expanse of wings 2 inches.

Santarem (*Dr. Trail*).

This is another Notodontid, allied to *S. politia* of Cramer, referred also to the Noctuites by Walker.

XXII.—*Preliminary Notices of Deep-Sea Fishes collected during the Voyage of H.M.S. 'Challenger.'* By Dr. Albert Günther, F.R.S., Keeper of the Zoological Department, British Museum.

[Continued from p. 28.]

Setarches fidjiensis.

D. $10 \mid \frac{1}{10}$. A. 3/5. P. 23.

The height of the body is one third of the total length (without caudal), the length of the head two fifths. Head scaleless, without prominent spines on the vertex, but with parallel ridges; interorbital space flat, as wide as the eye, the diameter of which is two ninths of the length of the head and two thirds of that of the snout. Upper jaw overlapping the lower, maxillary extending to below the middle of the eye; very narrow bands of villiform teeth in the jaws and on the vomer and palatine bones. The largest spines of the head are three at the angle of the præoperculum; smaller ones are distributed on the præorbital, the lower præopercular margin, and the operculum. The fourth dorsal spine is the longest, two fifths of the length of the head; the third anal spine is longer than the second. Pectoral extending to the anal fin.

Body covered with minute cycloid scales. Lateral line wide. Body irregularly mottled with brown.

Fidji Islands, 215 fathoms.

Cottus bathybius.

D. 5 | 10. A. 7. P. 17. V. 3.

The præoperculum is very strongly armed; there are two spines arising from the same root at the angle, one in front of the other, the posterior being longer than the eye; three other shorter spines along the lower edge of the præoperculum; operculum with a small spine at its antero-inferior angle. A pair of spines on the occiput behind a deep depression occupying nearly the whole of the vertex. Eyes longer than the snout, close together. Minute teeth on the vomer, but none on the palatine bones. Pectoral fin extending beyond the origin of the anal; ventrals not reaching the vent. Muciferous system much developed, opening by wide pores along the lower jaw, the præoperculum, the infraorbital ring, and the lateral line. Greyish brown; throat and all the fins black.

Japanese seas, 565 fathoms.

Echiostoma microdon.

D. 24. A. 29. P. 3. V. 7.

The length of the head is more than one fifth of the total (with the caudal). No separate pectoral ray; root of the ventral considerably nearer to the base of the caudal than to the extremity of the snout. All the teeth rather small, a few only in the middle of the palatine bone. Black; two luminous organs below the eye; a narrow elongate one above the maxillary, and a small short one nearer to the eye.

Off the north-west coast of Australia, 2440 fathoms.

Echiostoma micripnus.

D. 21. A. 23. P. 1/3. V. 7.

The length of the head is nearly one ninth of the total (with the caudal). Barbel much longer than the head, and fringed at its extremity; the anterior pectoral ray filamentous and distinctly separated from the others. Root of the ventral rather nearer to the extremity of the snout than to the root of the caudal. Black; luminous organ above the maxillary small, round, like a rudimentary eye.

Off the south coast of Australia, 2150 fathoms.

Malacosteus indicus.

D. 18. A. 20. P. 2. V. 6.

Closely allied to *M. niger*, but with a pair of long curved fangs on the extremity of the mandible.

Pacific, 500 fathoms.

BATHYOPHIS, g. n. Stomiatid.

Body extremely narrow and elongate, snake-like, naked. Vent far behind the middle of the length of the body. Head large, compressed, with the snout of moderate length, and with the cleft of the mouth nearly as long as the head. Teeth in the jaws extremely large, numerous, of unequal size, depressible. Similar teeth on the tongue and on each side of the vomer. Eye rather small. Opercular portion of the head narrow. A long barbel anteriorly on the hyoid. The dorsal commences above the ventrals, and extends nearly to the anal; the anal also is long, commencing behind the vent. Pectorals none. Ventrals inserted before the middle of the length of the body. A small phosphorescent organ above the middle of the upper jaw, and a series of small luminous dots along each side of the abdomen and along the outer ventral ray. Similar organs on the tail. Gill-openings extremely wide.

Atlantic.

Bathyophis ferox.

D. 60. A. 45. V. 3.

Barbel much longer than the head. Black.

Middle of North Atlantic, 2750 fathoms.

BATHYSAURUS, g. n. Scopelid.

Shape of the body similar to that of *Saurus*, subcylindrical, elongate, covered with small scales. Head depressed, with the snout produced, flat above. Cleft of the mouth very wide, with the lower jaw projecting; intermaxillary very long, styliform, tapering, not movable. Teeth in the jaws in broad bands, not covered by lips, curved, unequal in size, and barbed at the end. A series of similar teeth runs along the whole length of each side of the palate; a few teeth on the tongue and groups of small ones on the hyoid. Eye of moderate size, lateral. Pectoral of moderate length. Ventral 8-rayed, inserted immediately behind the pectoral. Dorsal fin in the middle of the length of the body, with about eighteen rays. Adipose fin absent or present. Anal of moderate length.

Caudal emarginate. Gill-openings very wide, the gill-membranes being separate from each other and from the isthmus. Eleven or twelve branchiostegals. Gill-laminæ well developed, separate; gill-rakers tubercular; pseudobranchiæ well developed.

Bathysaurus ferox.

D. 18. A. 11. P. 15. V. 8. L. lat. ca. 120.

Adipose fin none.
East coast of New Zealand, 1100 fathoms.

Bathysaurus mollis.

D. 15. A. 11. P. 15. V. 8.

Adipose fin present. Rays of the fins, especially the front rays of the dorsal, rather elongate.
Middle of South Pacific; off Yeddo: 1875 and 2385 fathoms.

Chlorophthalmus nigripinnis.

B. 7. D. 11. A. 9. L. lat. 50.

Similar to the Mediterranean *Chlorophthalmus Agassizii*. The length of the head is contained thrice and three fourths in the total length (without caudal); the eye is large, two fifths of the length of the head, and three times the width of the interorbital space. The distance of the adipose fin from the dorsal equals that between the latter and the front margin of the eye. Teeth in the jaws, on the vomer and palatine bones, in very narrow bands. Pectoral rather shorter than the ventral, which extends far beyond the vent, the vent being much nearer to the ventral than to the anal. Silvery, with some very indistinct darker spots on the sides of the body; top of the dorsal and extremity of each caudal lobe deep black.
Off Twofold Bay, 120 fathoms.

Chlorophthalmus gracilis.

B. 10. D. 11. A. 11. L. lat. 60. L. transv. 6/7.

The length of the head is one fourth of the total length (without caudal); the tail being slender, the distance between the end of the anal and the root of the caudal is not very much less than the length of the head. Distance of the adipose fin from the dorsal equal to that between the latter and the front margin of the eyes. Snout depressed, flat, with the lower jaw prominent; interorbital space broad, more than the vertical diameter of the eye. Eye large, its horizontal diameter being two ninths of the length of the head and two thirds of that of the snout. Teeth in the jaws *en cardes*, those on the vomer and palatine bones in a single series, the vomerine series being interrupted in the middle. The intermaxillary is toothed along the whole of its length, and extends nearly as far back as the maxillary, the extremity of which reaches to behind the eye. Pectoral considerably longer than the ventral, which does not extend to the vent, the vent being a little nearer to the anal than to the ventral. Origin of the dorsal fin immediately behind the root of the ventral. Scales ctenoid; those of the lateral line and between the ventral fins larger than the rest. Uniform brownish black; fins of a lighter colour.

Off the eastern coast of New Zealand; off Juan Fernandez; middle of South Atlantic: 1100, 1375, and 1425 fathoms.

BATHYPTEROIS, g. n. Scopelid.

Shape of the body like that of an *Aulopus*. Head of moderate size, depressed in front, with the snout projecting, the large mandible very prominent beyond the upper jaw. Cleft of the mouth wide; maxillary much developed, very movable, much dilated behind. Teeth in narrow villiform bands in the jaws; on each side of the broad vomer a small patch of similar teeth; none on the palatines or on the tongue. Eye very small. Scales cycloid, adherent, of moderate size. Rays of the pectoral fin much elongate, some of the upper being separate from the rest and forming a distinct division. Ventrals abdominal, with the outer rays prolonged, eight-rayed. Dorsal fin inserted in the middle of the body above, or immediately behind the root of the ventral, of moderate length. Adipose fin present or absent. Anal short. Caudal forked. Gill-openings very wide; gill-laminæ well-developed, separate from each other; gill-rakers long. Pseudo-branchiæ none.

Bathypterois longifilis.

B. 12. D. 13. A. 9. P. 3/13. V. 8. L. lat. 61.
L. transv. 6/10.

The uppermost pectoral ray is the strongest, longer than the whole fish, bifid towards its extremity. Outer ventral rays with dilated extremities. Dorsal fin inserted immediately behind the root of the ventrals. An adipose fin.

Near Kermadec Island, 520 and 630 fathoms.

Bathypterois longipes.

B. 12. D. 13. A. 10. P. 2/7–8. V. 7. L. lat. 55.
L. transv. 6/8.

The uppermost pectoral ray is the strongest, about as long as the whole fish, bifid towards its extremity. Outer ventral ray much prolonged, strong, but not dilated at its extremity. Dorsal fin inserted at some distance behind the root of the ventrals. Adipose fin present or absent.

Off the east coast of South America, 2650 fathoms.

Bathypterois quadrifilis.

B. 12. D. 14. A. 9. P. 2/9. V. 8. L. lat. 59.
L. transv. 6/8.

The uppermost and lowermost of the pectoral rays are filiform; the former bifid from near to its base, the latter simple. Outer ventral ray much prolonged, strong, not dilated at its extremity. Dorsal fin inserted close behind the root of the ventrals. Adipose fin present.

Off the coast of Brazil, 770 fathoms.

Bathypterois longicauda.

D. 12. A. 9. P. 2/9. V. 8. L. lat. 55.
L. transv. 6/8.

The uppermost pectoral ray is the strongest, longer than the whole fish, bifid from the middle of its length. The outer ventral ray, bifid nearly from its base, is much prolonged, filiform. Dorsal fin inserted at a considerable distance behind the root of the ventrals, and extending to above the anal. Caudal deeply forked, with the lobes prolonged. Adipose fin present.

Middle of Southern Pacific, 2550 fathoms.

Scopelus antarcticus.

D. 15. A. 20. L. lat. 38.

The height of the body is two ninths of the total length (without caudal); the length of the head is contained thrice and two thirds in it; the depth of the head equals its length without snout. The diameter of the eye is somewhat more than one third of the length of the head; distance between the posterior margin of the orbit and the præopercular edge one third of the diameter of the eye. Snout short, obtuse, with its upper profile descending in a strong curve, and with the jaws nearly equal anteriorly. The maxillary reaches to below the posterior margin of the eye, and is dilated behind. Cleft of the mouth oblique. The origin of the dorsal fin is nearer to the end of the snout than to the root of the caudal, behind the base of the ventrals; its last ray is in the vertical of the fourth or fifth anal ray. The pectoral extends to the middle of the ventral. Scales smooth, deciduous. There are seven round pearl-coloured patches between the adipose fin and the caudal.

Antarctic Ocean, 1975 fathoms.

Scopelus mizolepis.

D. 13. A. 9.

Height of the body two sevenths of the total length (without caudal), the length of the head rather less than two fifths; the least depth of the tail is one half of its free portion. Head very thick, with short snout. Eye very small, about one seventh of the length of the head and one half of that of the snout. Posterior margin of the præoperculum subvertical; lower jaw slightly prominent; cleft of the mouth rather oblique; the maxillary reaches to below the eye and is moderately dilated behind. Origin of the dorsal fin somewhat nearer to the extremity of the snout than to the caudal fin, and behind the base of the ventrals, which is below that of the pectorals; the last dorsal ray is above the middle of the anal. Pectoral fin long, extending at least to the middle of the anal fin. Adipose fin none. The scales, which are lost, appear to have been of unusually large size. Black.

South of New Guinea, 800 fathoms.

Scopelus crassiceps.

D. 15. A. 9–10. L. lat. 30?

The height of the body is one fourth of the total length (without caudal), the length of the head one third; the least depth of the tail is two fifths of its free portion. Head very thick, with short snout. Eye small, one seventh of the length of the head, and one half of that of the snout; posterior margin of the præoperculum descending obliquely backwards; lower jaw slightly prominent; cleft of the mouth rather oblique; the maxillary reaches to behind the eye, and is moderately dilated behind. Origin of the dorsal fin nearer to the extremity of the snout than to the caudal fin, and immediately behind the base of the ventrals; its last ray is above the anterior anal rays. Pectoral fin long, reaching to or beyond the end of the anal fin. Black.

Atlantic and Antarctic Oceans, 675–1500 fathoms.

Scopelus macrostoma.

D. 13. A. 13.

The body is highest where it joins the head, and rather rapidly becomes lower towards the tail; its greatest depth is rather more than one fourth of the total length (without caudal), the length of the head one third. Head thick, with the snout of moderate length, obtuse, and with the jaws equal in front. Bones of the head thin and flexible. Eye small, not quite one sixth of the length of the head, and two thirds of that of the snout. Posterior margin of the operculum oblique, rounded. Operculum narrow, membranaceous. Cleft of the mouth oblique, very wide, the maxillary reaching far behind the eye, viz. to the mandibular joint; it is obliquely dilated behind. Origin of the dorsal fin but little nearer to the extremity of the snout than to the root of the caudal, and not much in advance of the vent; its last ray opposite to the last ray of the anal. Pectoral rather small, scarcely extending to the origin of the dorsal. Ventral small, with five rays only; the caudal rays extend a considerable distance forward on the upper as well as lower sides of the tail. Transparent, with the sides of the head and the abdomen black.

Mid Pacific, 2425 fathoms.

Scopelus microps.

D. 21. A. 9. L. lat. 35.

The height of the body is one fourth of the total length (without caudal), the length of the head one third; the least depth of the tail is two fifths of its free portion. Head thick, with short snout; the skin with which it is covered shows a peculiar longitudinal striation, and is pierced by very conspicuous pores. Eye small, one seventh of the length of the head, and more than one half of that of the snout. Posterior margin of the præoperculum nearly vertical. Lower jaw prominent. Cleft of the mouth oblique; the maxillary reaches to below the posterior margin of the eye, and is slightly dilated behind. Origin of the dorsal fin behind the base of the ventrals, its length being two thirds of its distance from the snout. Its last ray is opposite to the first anal ray. Pectoral fin rather long, but not extending to the vent. Uniform black.

Mid ocean, between Cape of Good Hope and Kerguelen's Land, 1375 fathoms.

Ipnops, g. n. Scopelid.

Body elongate, subcylindrical, covered with large thin deciduous scales, and without phosphorescent organs. Head depressed, with broad, long, spatulate snout, the whole upper surface of which is occupied by a most peculiar organ of vision (or luminosity), longitudinally divided into two symmetrical halves. Bones of the head well ossified. Mouth wide, with the lower jaw projecting; maxillary dilated behind. Both jaws with narrow bands of villiform teeth; palate toothless. Pectoral and ventral fins well developed, and, owing to the shortness of the trunk, close together. Dorsal fin at a short distance behind the vent; adipose fin none. Anal fin moderately long. Caudal subtruncated. Pseudobranchiæ none.

Ipnops Murrayi.

B. 12. D. 10. A. 13. V. 8. L. lat. 55.

Vent nearly twice as distant from the root of the caudal as from the extremity of the snout.

South Atlantic, 1600–1900 fathoms.

Gonostoma elongatum.

D. 13. A. 29. V. 7.

The cheek is not entirely covered by the infraorbital. Dentition as in *G. denudatum*. The height of the body is one seventh of the total length (without caudal), the length of the head two ninths.

South of New Guinea, 800 fathoms.

Gonostoma gracile.

D. 10. A. 26. V. 6.

Apparently scaleless. The cheek is not entirely covered by the infraorbital. The larger teeth in the upper jaw rather numerous. The height of the body is one ninth of the total length, the length of the head one fifth. Tail very slender and narrow. Adipose fin none.

South of Japan, 345 and 2425 fathoms.

Gonostoma microdon.

D. 13. A. 18–21.

Cheek naked. Teeth in the upper jaw very fine and numerous, with some larger ones placed at regular intervals. Eyes small.

Atlantic and Pacific, 500–2900 fathoms.

[To be continued.]

XXIII.—*On* Lütkenia, *a new Genus of Ophiuroidea from Discovery Bay.* By Prof. P. Martin Duncan, M.B. Lond., F.R.S., &c.

[Plate IX.]

After the Echinodermata brought to England by the late Arctic Expedition under the command of Sir George Nares, F.R.S. &c., had been described by Mr. Percy Sladen and myself*, a box of specimens, which had been collected by Mr. Hart, naturalist to H.M.S. 'Discovery,' was found unopened. It was sent from the Royal Society to the British Museum; and Dr. Günther, F.R.S., very kindly placed the Echinoderms in my hands. Mr. Edgar Smith, F.L.S., drew my attention to the two fine specimens which form the subject of this memoir; and after dissecting one I found it desirable to describe them under a new genus, which has very remarkable peculiarities.

Genus Lütkenia.

Disk notched, covered with very small scales. Radial shields small, widely separate. Mouth-papillæ numerous. Tooth-papillæ. Teeth resembling tooth-papillæ in double series, with accessory knobs. Generative slits small, midway between mouth-shields and margin. Accessory scales to tentacular openings; tentacle-scales numerous; on mid arm two. Spines small, distant, irregular. Lower arm-plates very broad and short within the disk, and small and triangular without. Side arm-plates meeting below throughout, but not above. Upper arm-plates broad and keeled near the disk.

Lütkenia arctica, sp. nov.

The disk is large, subcircular in outline, tumid above and at the sides, flat below, and is notched over the arms ($1\frac{4}{10}$ inch in diameter).

The arms are twice and a half as long as the disk is broad, come well within it, are very broad within the disk, and considerably so until the second third of their length. They are flat beneath, convex and almost keeled above near the disk, and less so distally, tall at the sides, and generally triangular in outline. The arm-spines are very small and few in number. The colour is white with a little brown.

The upper surface of the disk and the interbrachial spaces, to the aboral edge of the mouth-shields, and except the

* Ann. & Mag. Nat. Hist. 1877, vol. xx. p. 449.

naked radial shields, have a stout flaccid derm covered with excessively minute scales. The radial shields are small, pear-shaped, narrow, and angular within, where they slightly overlap, and broad and curved without, with a free edge there; they are very distant, and bound the incision for the arm on either side ($\frac{2}{10}$ inch long). Many small scales, some elongate and others extremely small and oval, are situated between the radial shields and the arm. There are no radial scales with spines; and the generative plates are hidden.

The mouth-shields are small ($\frac{3}{20}$ inch long), about as broad as long, somewhat pentagonal, broadest without, angular within, the aboral edge being nearly straight. The sides of the shields are rather straight and are at right angles to the aboral margin for some space, and then they slope inwards to the oral point. An accessory plate exists, in some, between the oral angle of the mouth-shield and the side mouth-shields. The madreporic plate is cribriform.

The side mouth-shields are rather large, do not unite closely within, are long and rectangular, being widest at the side angle of the mouth-shield, where they are more or less pointed, curved, and rounded off.

The generative slits are short and linear; the edges are close together, and have on them small, flat, rounded spinules, sixteen or more on each; they are distant from the mouth-shields and from the margin of the disk; and a series of fine scales passes outwards from their distal end, by the side of the arm, to the margin. Other minute scales are in a patch on the oral side of the slits.

The jaws are rather long, stout, tumid and bossed, and form rather a sharp angle; and the lower edge of the jaw-plate is broad and stout; the angular spaces are wide and large; and the tentacles are very well developed.

There are mouth-papillæ and tooth-papillæ; and the teeth are in a double vertical series with some accessary knobs, so that they resemble large tooth-papillæ.

The mouth-papillæ are numerous, fourteen or fifteen to each angle, small, much joined together at their bases, irregular in size, shape, and number, short, and never very broad. At the apex of the angle, within the distinct jaw-plate, there are three principal and one or more smaller lowest tooth-papillæ. No satisfactory distinction, except that of position, can be made between these tooth-papillæ and mouth-papillæ. Above the three or more lowest tooth-papillæ the others are in a crowded vertical series. They are most numerous and small on either side; and there are six or seven pairs of large, long, pointed and irregular-shaped ones in the midst, and reaching up the jaw-plate to its upper end, occupying the position of the teeth. The side of the jaws, close to the jaw-plate, is occasionally covered with small and close papillæ; and there is a small accessory papilla close to and at the side of the uppermost large ones. The upper part of the jaw beneath the stomach is stout and tumid, and the jaw-plate is large and well developed.

There are two rounded knobs on the side of the jaw, above the attachment of the mouth-papillæ, which are in relation with the upper tentacle; and the lower tentacle of the angle has five or six short unequal-sized tentacle-scales, forming, with several accessory scales, an obliquely placed curved wedge-shaped mass within the first lower arm-plate and on either side of its oral margin.

The lower arm-plates, there being six or seven within the disk, are mostly very broad and very short; further out they are small and triangular, with an aboral projection. They form but a small portion of the lower surface of the arm. The side arm-plates meet below, from the first to the last, giving a broad and comparatively flat under surface.

The first lower arm-plate is unlike the others in shape, and it is elliptical in outline and much broader than long: the second, longer and very much broader than the first, is somewhat rectangular; its sides are slightly incurved; and there is a central angular process on the distal and proximal edges, from which there is a reentering curve on either side to the lateral angles of the sides of the plate.

The third lower arm-plate is very broad, extending across the arm; it is short, the relation of length to breadth being one to three; the sides are incurved for the tentacle, and are slightly convex towards their distal angle. There is an angular process or cusp on the broad oral margin, and a smaller one on the aboral; and there is a reentering curve on both sides of the processes, giving a very elegant outline. The fourth lower arm-plate is as broad as the third; but it is shorter, and the proximal angular process is more decided than that on the distal edge. The next plate is of the same general shape, but is shorter, and the proximal angle is more pronounced. From this plate to the end of the arm, the others narrow more and more, become angular at the sides and more or less triangular as a whole, and are broader without than within. There is a projection in the median line on the aboral margin, and a reentering curve on either side to the lateral angles; and the proximal angular process has faintly reentering curves on either side of it. Far out and towards the tip of the arm the lower plates become more quadrangular or diamond-shaped; they are small, broader than long, and there is an angular process without and within. At the tip the minute lower arm-plates have the distal edge curved; and they are angular orally.

The first lower arm-plate is separated from the side mouth-shields by several scales or plates which are continuous with the base of the tentacle-scales, already mentioned as being within and at the sides of the plate.

The second lower arm-plate has two or three small tentacle-scales on it. In some arms they are fused into one; or there may be several minute accessory scales present.

The third plate has the same number and accessory arrangement; and they are seen, more or less modified, in the fourth and fifth. The other lower arm-plates have no tentacle-scales.

The side arm-plates form much of the lower surface of the arms, and also the greater part of the sides in mid arm and towards the tip. All unite with their fellows along the median line below, and all are convex from side to side. The first, just touching its fellow in the median line, is oval in outline, broader than long; it supports five, short, closet entacle-scales on a curved base; and the tentacular opening is large and circular, having a rim of membrane. The second is broader than the first, touches its fellow, and has four tentacle-scales, and sometimes a fifth or a small accessory one.

The third side arm-plate, still broader than long, and not much longer than the second, touches its fellow by a longitudinal short and straight line. The margin without is curved boldly, and within very slightly; like the others it is flat below; and it has three tentacle-scales, the outer one being subspiniform. The fourth, still broader, is not longer; and its outer end is large and supports three tentacle-scales, one of which is sometimes wanting. The fifth plate is the broadest, is short and narrow towards the median line, where it has two small tentacle-scales close together; and there is a spinule external to them, and sometimes a second.

Between the tentacle-scales of these first five or six tentacles and the generative slit there are occasionally one or two spinules.

Towards the mid arm, the side arm-plates are tumid at the sides, nearly flat below, broader than long, and shortest where they are joined longitudinally. They have a sharp bend to reach the side of the arm, and terminate above in an angular edge by joining the outer edges of two upper arm-plates. Their distal margin, at the side of the arm, is thick, and supports two very small, distant, irregular, sharp, short spines and two tentacle-scales, the inner of which is small and scale-like; and the outer is usually, but not invariably, a minute spine longer than the scale and the other spines. Sometimes the two tentacle-scales are equal, and further out the largest spine becomes independent of the tentacle. There are often no spines, while some plates have several very minute ones. All are very ill-developed and small.

The side arm-plates form the bulk of the tip of the arm; but although convex at the sides and swollen above, they do not separate the small and somewhat elongated hexagonal upper arm-plates there.

The upper arm-plates, within the notch in the disk, are four in number, and are broad, short, and curved to form a convex roof-like surface. Until far out on the arm, all are much broader than long, and have slanting straight sides and very faintly curved distal and proximal margins; the plates are convex and angular longitudinally, and they form the upper and much of the side arm. A little beyond the mid arm the upper arm-plates are smaller, not much broader than long, broadest without, where they are curved; and further out they are longer than broad, narrow proximally, with sides reenteringly curved and the distal margin boldly curved without. Towards the tip the elongated hexagonal form is assumed, the distal edge being, however, curved irregularly.

Remarks.—Two specimens of this fine Ophiuroid were collected by Mr. Hart: one is in spirit, and the other is dry, in the British Museum; and they both have the same anatomical details.

The minutely scaled disk, the widely separated radial shields and their free aboral edge, the position and ornamentation of the generative slit, the presence of mouth- and tooth-papillæ, the absence of true teeth in the ordinary sense, the papillose nature of the jaws, the accessory scales to the tentacular openings, the shape of the lower arm-plates, the numerous tentacle-scales and few spines on the side arm-plates, and the angular roof-shaped upper arm-plates, whilst they partly suggest Amphiuran and Ophioglyphan affinities as a whole, cannot admit the forms under any described genus. The absence of spined generative and radial scales and the presence of tooth-papillæ separate the new forms from *Ophioglypha*; and the nature of the dental apparatus and tentacle-scales prevents their being placed in any hitherto known arctic genus.

There is, then, an evident necessity for the foundation of a new genus, as these forms are unlike any others. I have named it after Prof. Lütken.

EXPLANATION OF PLATE IX.

Fig. 1. *Lütkenia arctica,* from above. Natural size.
Fig. 2. *Lütkenia arctica,* from below. Natural size.
Fig. 3. Mouth-shield, side mouth-shields, jaw-angles, and mouth-papillæ and tooth-papillæ. Magnified 2 diameters.
Fig. 4. Tooth-papillæ, from below and obliquely. Magnified 2 diam.
Fig. 4 *a.* Representatives of the teeth, from above. Magnified 2 diam.
Fig. 5. Lower arm-plates and side arm-plates. Magnified 2 diam.
Fig. 6. Side arm-plates and spines. Magnified 2 diam.
Fig. 7. Upper arm-plates. Magnified 2 diam.

BIBLIOGRAPHICAL NOTICE.

A Manual of Zoology for the Use of Students, with a General Introduction on the Principles of Zoology. By Henry Alleyne Nicholson, M.D., D.Sc., M.A., Ph.D., F.R.S.E., F.G.S. Fifth Edition, revised and enlarged. 8vo. Blackwoods; Edinburgh and London, 1878.

We welcome the appearance of this new edition of Prof. Nicholson's 'Manual of Zoology,' of some previous issues of which we have had occasion to speak in terms of praise. As a general systematic treatise on the structure and classification of animals it is the best that we possess; and the author's industry has enabled him in the present edition, which is much enlarged, to improve his work very greatly. Still the work is rather a manual of animal morphology for the use of students than a treatise on zoology in the broad sense of the term; but we must be thankful for what we get, and it must be confessed that it would be impossible, even within the limits of the present enlarged volume, to combine an equally satisfactory account of the organization, development, and structure of animals with a good sketch of their relations to each other and to the outer world. In this latter particular we are nevertheless glad to see that Prof. Nicholson has now gone further than in previous editions. The increase in the number of pages is considerable; but besides this the author has further gained space by printing certain portions of his work in small type.

In its general arrangement this edition differs so little from its predecessors as not to require any detailed notice. On nearly every page, however, we find traces of alterations made in consequence of recent researches in different branches of zoology: the chapters on Sponges and Hydroids and on Entozoa seem to have received great additions; and the results of the recent investigations of the American palæontologists upon the rich accumulations of vertebrate remains found in their Secondary and Tertiary rocks have led to considerable additions being made to the chapters on Vertebrata. We notice that that most unnatural group, the Annuloida, still figures as a primary division of the animal kingdom; let us hope that it will disappear from the next edition, as its founder may be considered to have already given it up.

In his preface and elsewhere Prof. Nicholson objects to the modern school of embryological systematists, and, we think, with reason. That embryological facts may frequently serve as guides in classification, nay, that a classification which is in contradiction to a broad embryology should be regarded with distrust, we are quite ready to admit; but we must know much more about the embryogeny of animals before we can accept the views of those who hold that their interpretation of the earliest stages of development is to override all indications derived from the study of the adult animals.

This edition contains a considerable number of new illustrations, which will materially increase its usefulness as a student's manual. An entirely new feature is the introduction of Bibliographical lists indicating the principal works of reference to be consulted in search of further information upon the different classes of animals. These lists might easily be improved both by additions and omissions; but as they are they will be found very serviceable.

MISCELLANEOUS.

On a new Opisthocœlous Dinosaur. By Dr. E. D. Cope.

I have recently received from the Dakota beds of Canyon city, Colorado, a number of bones of a new and remarkable extinct reptile allied to *Camarasaurus* (= *Titanosaurus* and *Atlantosaurus*, Marsh) and *Streptospondylus*. The dorsal vertebræ are strongly opisthocœlous, and are without lateral fossa or foramen of the centrum. The arch is freely articulated with the latter, and is not much elevated, and possesses no hyposphen. The neural spine is transverse; the diapophysis is supported on narrow buttresses, and the neural arches generally lightened by fossæ as in the two genera named. A strong parapophysial tubercle near the anterior convexity receives the head of the rib. Each zygapophysis of one side is separated from that of the other by a deep concavity. The genus so characterized may be called *Epanterias*, and the species *E. amplexus*. The latter has a rather low and wide dorsal neural arch with small fore and aft diameter, and with a neural spine divided into three obtuse apices. There are three fossæ at the base of the diapophyses, the anterior one vertical, and a very deep one between the posterior zygapophyses. The cup of the centrum embraces the ball extensively; and the neurapophysis overlaps the side of the centrum behind. Length of centrum ·115 m.; diameters behind, transverse ·120, vertical ·108. Elevation of neural arch ·290; width of neural spine ·083, of both diapophyses ·400. This saurian was much smaller than the *Camarasaurus supremus*, and, perhaps, equal to the *Hadrosaurus Foulkei*. It may be associated with the former in the *Camarasauridæ*. With *Amphicœlias* is probably in like manner to be arranged *Tichosteus*; while the carnivorous form *Hypsirhophus* represents a third type.—*American Naturalist* for June 1878.

On the Propagation and Metamorphoses of the Suctorial Crustacea of the Family Cymothoadæ. By M. Schiödte.

Having been enabled, by the liberality of the directors, to bring together all the Cymothoadæ existing in the principal zoological museums of Scandinavia and Germany, I propose, with the collaboration of Dr. Meinert, Assistant Naturalist at the Museum of Copenhagen, to publish an extensive memoir on the natural history of those Crustaceans, including their biology, their morphology, and the description of their genera and species. MM. Milne-Edwards and Heinrich Rathke were the first to make known the young stages of several Cymothoadæ; nevertheless the study of these marine animals has furnished us with new facts of general interest upon the subject of their metamorphoses. In my own name and that of Dr. Meinert I have the honour to communicate them to the Academy.

When the young issue from the ovum in the oviferous pouch of the female they are perfectly smooth; the antennæ of the first pair have no olfactory threads; the antennæ of the second pair, the last segment of the tail, the feet, and the branchiæ are entirely destitute of natatory cilia. It is during the first moult, which takes place before the little animal has quitted the maternal oviferous pouch, that all these parts are developed. At the same time we observe more or less considerable changes in the form of the young animal, and in the configuration of its appendages, especially of the tail—changes which all tend towards the same end, namely to convert the creeping animal of the first stage into a swimming animal. The subsequent changes which take place during a long series of moults in the little Cymothoad swimming freely in the sea, where it derives its nourishment from the blood or the mucus of fishes, render it more and more fitted for rapid natation, at the same time that the constantly advancing progress of development enables it to attach itself better to the bodies of fishes. It is at this period of free natation that the feet of the seventh pair are developed; the epimera of these feet, which are wanting in young specimens before the second moult, begin to separate themselves from the seventh segment of the body. Up to the fourth moult the feet of the last pair, which are completely smooth, increase in size, remaining applied beneath the ventral surface and directed inwards, in such a manner that one cannot see them when looking at the animal from above. During this period the ventral surface of the females remains entirely plain, without traces of the sexual orifices and oviferous pouch; in the males, on the contrary, the corresponding orifices become more and more visible on the ventral arch of the seventh segment of the body as soon as the feet of the last pair have attained perfection.

When arrived at the adult state, the individuals of the two sexes retire to copulate. The *errant suctorial Cymothoadæ* seek a shelter in the depths of the sea. The females of many *parasitic* Cymothoadæ attach themselves strongly to the skin or fins of fishes; others penetrate into the branchial or buccal cavity of those animals—the latter hooking themselves firmly on to the surface of the tongue, with the head directed forwards towards the opening of the mouth of the fish. Usually one male keeps beside the female; sometimes several males are met with near a single female.

The moults take place in all these Crustacea in a peculiar manner. The skin first of all quits the hinder part of the body, the animal remaining strongly attached by the front legs; the anterior part of the body is disengaged in its turn in the same manner, the animal being then attached by the new claws of the hinder feet. This mode of changing the skin is an absolutely necessary condition for the copulation. In fact, the act would become impossible if the oviferous pouch of the female were formed at once beneath all the segments of the body, thus stopping the sexual orifices, which are formed at the same time towards the sides of the ventral arch of the fifth segment. But the oviferous pouch, half-formed after the moult of the posterior part of the body, having as yet only three lamellæ, which are attached to the last three segments of the body, remains broadly open in front; and the male can easily make his way into it. After copulation, the female, changing the skin of her anterior part, at the same time completes the oviferous pouch with the lamellæ belonging to that region of the body. It is to be remarked that the anterior lamellæ of the oviferous pouch cover the jaw-feet and often the mouth itself—an arrangement which proves that the female now takes scarcely any more nourishment. The lamellæ being directed forward, it is in this direction beneath the head that the young issue from the oviferous pouch after their first moult. The female remaining attached and motionless during the deposition of the ova, dies flaccid and empty after the escape of the young.

In many of these Crustaceans, especially in the errant suctorial Cymothoadæ, the young are very large in proportion to the adult animal, and, to make up for this, are not very numerous; in others, on the contrary, the young, to the number of a couple of thousand, are of extreme minuteness. As a matter of course, these proportions are in direct relation with the greater or less difficulties which the young must encounter during their evolutive life, according to the mode of life of the different fishes to which they attach themselves. In the young the configuration and the relative size of the head, antennæ, eyes, and the last segment of the tail and its appendages, and the number, form, and distribution of the pigment spots, present a multitude of differences according to the species. The claws, which are always simple and but slightly curved before the first moult, often become strongly serrate after this moult—a structure which is gradually lost during the following moults. All these differences during youth frequently become a great assistance in the specific distinction of the adult animals, especially when the latter, as is the case in a great proportion of the parasitic Cymothoadæ, have undergone a retrograde metamorphosis as they increased in age. The females, converted into a more or less shapeless oviferous sac, lose to a great extent the symmetry and the definite form which distinguished their different appendages during the natatory stage of their life. Even in the errant suctorial Cymothoadæ the female undergoes considerable changes in becoming oviferous: the segments of the body shorten; the first segment of the tail becomes more or less completely hidden beneath the seventh segment of the body; &c. These differences often deceptively simulate zoological characters.—*Comptes Rendus*, July 8, 1878, p. 52.

On Avenardia Priei, *a Gigantic Nemertean of the West Coast of France.* By M. A. Giard.

The Nemertean which forms the subject of this note measures as much as 1 metre or even 1·20 metre in length when in a state of repose; when it extends itself its length may become three or four times as much. Its breadth attains 2 or 3 centims.; and the general form of the body is flattened. In the contracted state the lateral margins often appear undulated or notched, as is observed also in the *Tæniæ* and *Ligulæ*.

This worm is met with by hundreds at Pouliguen (Loire-Inférieure), but in a peculiar station—namely, in an old canal (*étier*) of the salt marshes, now converted into a reservoir, in which the sea-water is renewed every tide. The water of this reservoir serves to set in motion the wheels of an establishment managed by M. Avenard. The workmen here have been acquainted with this enormous Nemertean for a number of years. They meet with it, at a depth of from 10 to 20 centims. in the mud, whenever they clean out a portion of the reservoir. The salters, whom I have asked about it, have not observed it any where else in the salt marshes. It is equally unknown to the fishermen of the port of Pouliguen, as also to those of Croisie.

The principal animals which inhabit the mud of the reservoir are several species of Nereids (one of which is peculiar to brackish waters), *Pholades* (*P. dactylus* and *P. candida*), *Scrobiculariæ,* flat-fishes, and eels. Oysters, which have lately been introduced into the reservoir, thrive there remarkably. The thousands of Nemerteans extracted from the mud during cleansing-operations are devoured with avidity by domestic ducks.

The Nemertean hollows out in the mud long galleries, which it lines with a mucous coating, so that no earthy particle can soil its epidermis. When put into the water it swims with the greatest facility, by performing undulatory movements, giving it an astonishing resemblance to an eel. Its colour, moreover, sufficiently resembles that of this fish: the back is of a more or less dark blackish grey, and quite black along the median line; the belly is entirely white or yellowish white.

When taken out of the water, instead of stretching softly, like *Lineus longissimus*, the animal breaks up very rapidly into a multitude of fragments, which become smaller and smaller. When the division stops, the fragments are scarcely more than 2 centims. long; and each of them has acquired a rounded form, in consequence of the contraction of the muscles, which gradually diminishes the open surface of the section, and finally causes it to disappear entirely. To obtain an entire specimen the most certain method is to throw the worm suddenly into absolute alcohol, or to make it die slowly in the water by gradually substituting fresh water for the sea-water in which it is immersed. We frequently find individuals which have regenerated a more or less considerable portion of their body. When placed in a liquid which does not suit it, the worm pushes out its trunk and throws it off. The trunk, thus isolated, still continues to live for a long time; it invaginates and evaginates itself, and moves with a tolerably rapid creeping motion. One might suppose that we had here a case of viviparity.

The organization of our Nemertean is precisely that of the unarmed Nemerteans or Anopla; but the generic characters do not agree with those of any type previously described. The head, which is clearly distinct from the body, has the form of a heart with the point directed forward, and presents an aperture for the protrusion of the trunk. The sides of this head are occupied, throughout their whole length, by two enormous longitudinal cephalic fissures. The upper part is strongly pigmented, but there is no apparatus of vision, which may easily be explained by the subterranean existence of the animal. The mouth occupies the anterior and ventral part of the trunk; it is about 1 centim. in length, and consequently quite visible to the naked eye. The anterior part of the body, for a length of about a decimetre, is occupied by a straight œsophagus situated beneath the cavity of the trunk. Following this œsophagus the digestive tube proper commences. This point is marked by a change in the musculature. Here begins a ventral furrow, which traverses the whole body of the animal to the anus.

The cæca of the intestine are not placed opposite to each other two and two; on the contrary, there is a very marked alternation in the points of insertion of these organs to the right and left of the digestive tube. The cæca are not simple; they branch at their extremities into secondary diverticula, in such a manner that the intestine presents a true *dendrocœlism*. Such an arrangement as this had only been indicated previously in a pelagic Nemertean, the curious *Pelagonemertes Rollestoni*, two specimens of which were collected and studied by Moseley during the 'Challenger' expedition.

The lateral vessels do not appear to be so well organized as the dorsal trunk; they are rather lacunæ, comparable with those which occupy the same position in the Cestodea. Perhaps they may stand in relation to the genital organs, which alternate with the cæca of the digestive tube; I have not met with specimens young enough to decide this question.

The genital pores do not open upon the sides of the body, as is the general rule in the Nemerteans, but upon the dorsal surface and on each side of the median dorsal line. They are disseminated in an alternate and slightly irregular fashion, nearly like the pores of the ambulacral plates of certain sea-urchins. The spermatozoids are perfectly filiform, and very long. The ova are exceedingly small, and are laid separately, each surrounded by a thick mucous envelope. The nutritive vitellus is scanty. Therefore, although I have not been able to follow the development, I am convinced that the embryogeny must be dilated and that the larva must affect the *Pilidium*-form.

I give this remarkable Nemertean the name of *Avenardia Priei*, dedicating it at once to M. J. Prié, a zealous naturalist of Pouliguen, and to M. Avenard, Assistant to the mayor of Pouliguen, who furnished me with the materials of this investigation, and facilitated these sufficiently troublesome researches with a kindness for which I am glad to thank him publicly.—*Comptes Rendus*, July 8, 1878, p. 72.

Observations and Experiments on the Migrations of Filaria rhytipleurites, *a Parasite of Cockroaches and Rats.* By M. Osman Galeb.

In 1824 Deslongchamps discovered, in the fatty body of the common cockroach (*Periplaneta orientalis*), a great number of small lenticular bodies visible to the naked eye, in which he found a small Nematoid worm to which he gave the name of *Filaria rhytipleurites*. This encysted worm merely represents the asexual state of a Nematoid, the migrations of which have hitherto remained unknown.

The cyst forming the cell of this animal is composed of two membranes: the external, which is fibrous, is easily coloured by carmine; the inner one, on the contrary, which is structureless and sometimes presents a granular appearance, does not fix the colouring matter. The larva, whose movements may easily be followed through the wall of the cyst, is folded several times upon itself and surrounded by a whitish granular matter.

These Nematoids cannot quit their prison so long as the *Periplaneta*, of which they are parasites, continues alive. If by dissection we separate the cysts and then place them in a suitable liquid, the little worms soon pierce their cells; half an hour of submersion gives them all their liberty; and their vitality is such that they can remain alive for three days, or even more.

It is by chance that I have discovered the course of the migrations. The baker with whom I was lodging, knowing that I was interested in natural history, placed at my disposal all the rats caught in his traps. On opening the stomach of one of these animals (*Mus decumanus*), which I killed in order to make some histological preparations, I found a Nematoid in the sexual state, and easily established its identity with that which I had met with in the adipose tissue of the cockroach: a cutaneous fold which exists in the body of the larva at but a short distance from the anterior extremity occurs also in the adult animal at the same part; and it was this characteristic fold that suggested the name *rhytipleurites*, given by Deslongchamps to the encysted worm.

The Nematoid when set free grows rapidly; for the larva contained in the cyst does not measure more than 11–16 millims., while the adult worm often attains a length of more than 2 centims., the male being, as usual, smaller than the female.

The cuticle is thick, regularly annulated; in the larva it contains numerous porous canals. The muscular system forms a continuous layer, which places this worm among the Holomyaria. Within this muscular layer the cavity of the body is occupied in the centre by the digestive tube, and in the interval by a spongy tissue formed by intercrossed fibres, the meshes of which are filled with large, round, nucleated and nucleolated cells.

The single ovary is straight, and formed by a tube with a central rhachis, to which the ova are attached laterally like the barbs of a feather. The vulva opens not far from the mouth. The male possesses a simple spicule; his posterior extremity is twisted like a crozier.

The specific identity of the encysted larva and the free adult appeared to me to be sufficiently proved by the anatomical characters; but in order to arrive at more absolute certainty, I undertook some experiments in artificial migration. As I found it difficult to manage the rats caught in traps, in which these migrations would naturally take place, I made use of white rats (*Mus rattus*), which I fed with cockroaches infested by these parasites. The three rats experimented on were killed in a week, when I found in the anfractuosities of the mucous membrane of the stomach the Nematoid in question, alive and freed from its envelopes. In one of the rats I found three females and a male, all of which had acquired their reproductive organs.

Thus the last period of evolution is accomplished. The copulation takes place in the digestive tube of the rat; and soon afterwards the deposited ova are ejected with the fæcal matters. I do not know whether these ova contain a ready-formed embryo. However this may be, these ova are swallowed by the cockroaches, whose voracity drives them to devour the excrement of the rats; the embryos are then hatched in the digestive tube of those Orthoptera, pierce its wall, and go to encyst themselves in the adipose body, to wait there until the *Periplaneta* is in its turn eaten by the Rodent, in which the evolution-cycle will be completed. A very simple observation also enables us to demonstrate how the migration of *Filaria rhytipleurites* is effected. Having examined the matters contained in the intestine of *Periplaneta orientalis*, I found there a great quantity of rat's hairs. Now the rats, as indeed all the Mammalia, by licking themselves, introduce into their digestive tube a considerable mass of hairs, which are got rid of with the fæcal matter. It is therefore certain that the hairs which are met with in the alimentary canal of the cockroaches have been brought there with the fæces of the rat, and that the ova of the Nematoids were ingested at the same time.

The observations and experiments just detailed seem to me to be of some interest, as hitherto only a single case of the peregrination of a Nematoid from an insect to a mammal, and *vice versâ*, was known*.—*Comptes Rendus*, July 8, 1878, p. 75.

* Leuckart has discovered that *Spiroptera obtusa*, encysted in the larva of *Tenebrio molitor*, completes its development in the digestive canal of the mouse.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 9. SEPTEMBER 1878.

XXIV.—*On the Occurrence in North America of rare Extinct Vertebrates found fragmentarily in England.* By Prof. R. Owen, C.B., F.R.S., &c.

[Plates X. & XI.]

Part I. Restoration of *Chondrosteosaurus.*

Of such species, one of the most, if not the most, extraordinary which has come under my observation is the extinct reptile on certain vertebræ of which I founded, in 1876, the genus *Chondrosteosaurus* and the species *Ch. gigas**.

The centrum of an "anterior trunk-vertebra," the position of which, by characters continued, in *Crocodilus*, from the posterior cervicals to the anterior dorsals, I would not more precisely define, presented a length of 1 foot 3 inches (375 millims.). Another and more posterior vertebral centrum, and a third more mutilated one, of which I made a section showing its imperfectly ossified structure, were, and still are, all the evidences of *Chondrosteosaurus* which have reached me from British Wealden strata: the locality was the submerged bed on the south coast of the Isle of Wight.

I am of opinion, however, that our knowledge of this huge and singular Saurian has been extended by discoveries, in 1877, of fossil remains in the Mesozoic formations of Fremont County, Colorado, U. S., due to the persevering researches of the Superintendent of Public Schools in that county, Mr. O. W. Lucas.

* "Monograph on the Fossil Reptilia of the Wealden Formations," in the Palæontographical Society's volume issued in 1876, p. 5, pls. ii.–v.

This opinion is grounded on the following concordancies of the characters which I assigned to the genus with those noted by Prof. E. D. Cope in a seemingly homologous vertebra, which he terms "cervical," and which was submitted to his examination by Mr. Lucas.

1. *Terminal Articulations of Centrum.*

The first character which I assigned to *Chondrosteosaurus* was founded on the form of the terminal articular surfaces of the centrum. "The hemispheroid convexity of the anterior end (*a*)" was proved to be such, notwithstanding some abrasion of the fossil, "by the more perfect preservation of that surface in the opposite concave articular end, *b* (plate iii.)"*.

The vertebræ, at least at the fore part of the trunk, were thus of the type which I have characterized as "opisthocœlian"†.

Prof. Cope states that "a cervical and three dorsal vertebræ" of the Saurian here compared "have a ball-and-socket articulation of the opisthocœlian type"‡. This character, however, in parts of the vertebral column is common to other genera (*Streptospondylus*, *Cetiosaurus*, *Iguanodon*, e. g.)§.

2. *Osseous Structure.*

The next character of *Chondrosteosaurus* is taken from the osseous structure of the vertebræ. It was yielded by "the large cancelli obvious at every fractured surface of the vertebra," and was further tested and exemplified by "a vertical longitudinal section of a rolled and worn centrum of a second anterior trunk-vertebra, figured three fourths of the natural size in plate v. fig. 2"‖. Of these cancelli it is remarked, "I deem it much more probable that they were occupied in the living reptile by unossified cartilage or chondrine than by air from the lungs"¶. They might be termed, from their size, huge internal sinuses.

So Prof. Cope writes, "A broken centrum, from which Mr. Lucas removed the matrix, shows that this foramen communicates with a huge internal sinus, which occupies almost the entire half of the body of the centrum. Those [sinuses]

* Monogr. cited, p. 5.

† Reports on British Fossil Reptilia, *passim*; Anat. of Vertebrates, 8vo, vol. i. p. 59; and 'Palæontology,' 8vo, p. 300.

‡ "On a gigantic Saurian from the Dakota Epoch of Colorado," in the Palæontological Bulletin, no. 25, 8vo, p. 5, published August 23, 1877.

§ Report on British Fossil Reptiles, pt. ii. 1841, pp. 88–102.

‖ Monogr. cited, pp. 6, 7.

¶ Ibid. p. 6.

of opposite sides are separated by a [bony] septum which is thin medially"*. In the 'Palæontological Bulletin,' no. 28, the author writes, "the centra of the dorsal vertebræ are hollow, including two large chambers which are separated by a longitudinal wall"†.

In regard to the "cervical vertebra," Prof. Cope speaks of "the interior chambers"‡ as differentiating them from the "dorsal centra," in which "there are but two chambers, which are separated by a longitudinal median septum" §. Such is the difference indicated in the more anterior and the less anterior of the trunk-vertebræ from the Isle of Wight in regard to my second character of *Chondrosteosaurus.* It does not appear, however, that this largely cancellous structure was investigated or exposed in the Colorado vertebræ, as in the British Wealden ones, by special sections; allusion is only made by Prof. Cope to the "broken centrum from which Mr. Lucas had removed the matrix"||.

I believe myself justified nevertheless in concluding that the characters, from internal structure as from terminal articulations and lateral fossæ, on which the genus *Chondrosteosaurus* was founded, equally denote the "gigantic Saurian from the Dakota epoch of Colorado."

3. *Costal Articulations.*

A third character, if an extinct reptile be indicated solely by cervical or anterior dorsal vertebræ, is to be derived from the processes or surfaces which such vertebræ afford for the articulation of the ribs. In modern Reptilia such processes are single on each side in lizards, double in crocodiles. For the needs of intelligible description of the numerous and varied fossil vertebræ submitted to or observed by me in the course of preparing my 'Report on British Fossil Reptiles' (1840 and 1841), I proposed to call, in the vertebræ showing the double joint, the lower or capitular articular costal process "parapophysis," the upper or tubercular one "diapophysis."

In characterizing the Wealden fossils in question it is written:—"That the vertebra is from the fore part of the trunk may be inferred from the presence, on each side, of both a parapophysis (plate ii. *p*) and a diapophysis (ib. *d*), indica-

* *Loc. cit.* p. 5.

† 'Proceedings of the American Philosophical Society,' vol. xvii. no. 100, May to December, 1877, p. 233.

‡ *Loc. cit.* p. 334. § *Loc. cit.* p. 235.

|| Pal. Bull. no. 25, p. 5, August 23, 1877.

tive of the bifurcation of the proximal end of the rib into a a capitular and a tubercular articulating process "*.

Of "the supposed cervical vertebra" from Dakota, Prof. Cope writes:—"Near the anterior extremity a short robust parapophysis has its origin, from which it extends outwards and downwards, and soon terminates in a truncate extremity which presents downwards. A deep fossa occupies its upper base; and above this a deep linear foramen extends throughout the greater part of the length of the centrum."

Of the dorsal vertebræ Prof. Cope writes:—"The widely extended diapophyses support the rib-articulations; and there are no capitular articular facets on the centra; but such are found on the basal region of the diapophyses in some vertebræ"†.

So, likewise, in a vertebra of *Chondrosteosaurus* which had "come from a more posterior part of the column," I note that "the parapophysis" (or "capitular articular facet") "had disappeared, at least from the position from which it projects in the subject of plate ii." ‡

Thus there is correspondence of the fossils compared in characters of the rib-joints, as in those of the terminal articulations and of the osseous texture.

4. *Parapophysis.*

But this correspondence is further carried out in the shape, direction, and position of the parapophyses of the cervical or anterior trunk-vertebræ. In *Chondrosteosaurus* "the fore part of the base of the process occupies the lower vertical half of the centrum, commencing at some distance from the hind end, and terminating very near the beginning of the anterior articular ball" §.

The close similarity in proportion and position of the parapophyses (p) is exemplified in Pl. X. fig. 1, from the reduced view given in my 'Monograph' of 1876, pl. ii. fig. 2—and in that (Pl. X. fig. 3) copied from fig. *a*, pl. i., appended by Prof. Cope to the paper "On the Vertebrata of the Dakota Epoch of Colorado," in the 'Proceedings of the American Philosophical Society,' no. 100, vol. xvii. 1877.

5. *Fossæ of Centrum.*

To come to minor characters. In *Chondrosteosaurus* "the whole side of the centrum is occupied by a deep oblong de-

* Monogr. cited, p. 5.

† Pal. Bull. no. 25, 1877, p. 7.

‡ Monogr. cited, p. 7.

§ Ibid. p. 7.

pression, which probably lodged a corresponding saccular process of the lung. On one side this depression was partially divided by a thin oblique plate (pl. v. fig. 1, *f*, *f*); its relative position beneath the base of the diapophysis is shown at d''*.

So also in the "enormous Saurian of the Dakota group," "just beneath the diapophysis is situated a huge foramen"†. And in Prof. Cope's subsequent and fuller description, "the centra of the cervicals and dorsals are hollow, and the interior chambers communicate with the cavity of the body by a large foramen on each side, which is below the base of the diapophysis. In the cervical region it is very elongate, and extends between the bases of the parapophysis and diapophysis"‡.

6. *General Proportions and Shape.*

The centrum of the anterior trunk-vertebræ of *Chondrosteosaurus*, the subject of plates ii., iv., and v. fig. 1, is notable for its great longitudinal and small vertical diameter and the flatness of the under surface (Pl. X. fig. 1).

So likewise with the Dakota Saurian, "The supposed cervical vertebra is depressed; the anterior or convex extremity is the most so. It is remarkable for its elongate form, exceeding the proportions found in known *Dinosauria* and *Crocodilia*"§. In truth the only known vertebra of considerable proportions was the subject described and figured, under the heading "Order Dinosauria (?); Genus *Chondrosteosaurus*; species *Chondrosteosaurus gigas*, Owen," in the Monograph of 1876.

7. *Size.*

But, huge as were the fossil vertebræ from the Wealden, which suggested the *nomen triviale*, they are surpassed by the subjects of Prof. Cope's description.

The length of my specimen was 1 foot 3 inches; and I ventured to state, with respect to this dimension, that the vertebra equalled "in length the largest one of any Cetacean recent or fossil"‖.

Of the Dakota monster Prof. Cope states, "the dimensions of the animal to which they belonged may be inferred from the fact that the first [cervical vertebra] is twenty inches

* Monogr., Pal. Soc. vol. 1876, p. 6.
† Pal. Bull. no. 25, 1877, p. 5.
‡ Proc. of Amer. Phil. Soc. 1877, p. 236.
§ Pal. Bull. no. 25, 1877, p. 5.
‖ Monogr. 1876, p. 6.

in length and twelve in transverse diameter, and that one of the dorsals measures three and a half feet in the spread of its diapophyses, two and a half feet in elevation, and the centrum thirteen inches in transverse diameter" *.

From the numerous and close agreements demonstrable between my "anterior trunk-vertebra" and Prof. Cope's "supposed cervical vertebra," I am quite prepared to receive from our submerged Wealden deposits of the Isle of Wight a dorsal vertebra rivalling the dimensions of the Dakota one, in the ratio of 1 foot 3 inches to 1 foot 8 inches, which differentiates the dimensions of the more advanced vertebræ compared. But that so rich an accession of illustrations of this probably "largest or most bulky animal capable of progression on land" † as the Dakota rocks have revealed at their outcrop, should be extracted from the resting-place of the British giant, would be an event that I cannot flatter myself that I shall contemplate during the brief remnant of my working days.

Concluding, from the seven characters assigned in the monograph of 1876 to *Chondrosteosaurus*, that the remains from Dakota, affording their describer the same seven characters, are of that genus and probably of the same species, the additional elements toward its reconstruction brought to light by Mr. Lucas and described by Prof. Cope constitute a most acceptable and interesting accession to the knowledge of extinct Reptilia.

In Prof. Cope's 'Palæontological Bulletin,' no. 25, he reports, "The vertebræ comprise a cervical, three dorsal, and four caudal vertebræ" ‡.

The characters of the first two kinds are quoted above.

"The caudal vertebræ are amphicœlian, but not deeply so; they are subquadrate in section." "The most anterior one of the series has short robust diapophyses, and is more concave anteriorly than posteriorly. The other caudals are more equally biconcave; but the cavity is very shallow on the most distal of them. The centrum is also relatively more elongate and compressed than those of the others. None of them display the lateral pneumatic fossa which exists in the dorsals; and where broken, so as to permit a view of the internal structure, the latter appears to consist of rather finely spongy tissue. The chevron-facets are not very well defined; and the neural spines are of the usual forms, and on the anterior two vertebræ elongate.

"The dorsal vertebra which I suppose to be the anterior

* Pal. Bull. no. 25, 1877, p. 5. † Ibid. ‡ Ibid.

one of those received, is characterized by its undivided transverse neural spine. The entire neural arch is of enormous elevation; but as the zygapophyses" (Pl. X. fig. 4, *z*, *z'*; the letters indicative of parts are added to my copy, not being given in the original) "are above its middle, the neural spine [ib. *ns*] is not as long relatively as in various other genera, or as in the caudals of this one. The sides of the centrum [*c*] are strongly concave, and the borders of the cup [*c'*] flaring. The neural arch is everywhere excavated, so as to reduce the bulk and produce lightness so far as consistent with strength. The diapophyses [*d*] rise from a point above the neural canal, and are directed upwards as well as outwards. It sends a narrow ridge down to the sides of the centrum, on each side of which its shaft and base are deeply excavated. The posterior of these fossæ is overlooked by the wide zygapophysis [*z'*]; and the roof of the anterior one supports the anterior zygapophysis [*z*]. The former are separated by another and vertical septum, which bifurcates below, forming two prominent borders [*n*, *n'*] of the neural canal. At each side of the base of the neural canal there are two trilateral fossæ, of which the anterior [*p*] is much larger and extends higher up on the lateral edge of the spine. They are separated by a lamina. The diapophysis [*d*] is not very long, and is subtriangular in section near the extremity. The neural spine is thickened at the extremity as though for the attachment of a huge ligament. At the summit of its posterior basal fossa, at the middle of its height, is an outwardly curved process, with a smooth extero-superior face.

"*Measurements.*

	m.
"Length of centrum	·275
Total elevation of vertebra	·830*
Elevation to posterior zygapophyses	·550
Elevation of superior edge of diapophyses above centrum	·350
Elevation of neural spine above posterior zygapophyses	·295
Length of diapophysis behind	·215
Depth of extremity of ditto (restored)	·075
Transverse extent of summit of neural spine	·215
,, ,, neural spine at middle	·330

"Another dorsal vertebra is better preserved than the last described. It is distinguished by the lack of the median portion of the neural spine and the extension outwards of the

* [= 2 feet $8\frac{1}{2}$ inches.]

median lateral processes described above. The diapophyses are much larger, and the zygapophyses more extended transversely. The centrum is constricted at the middle, and especially just behind the convex articular extremity, whose circumference forms a prominent rim. The edges of the lip are flared outwards, forming a deep basin, much wider than deep. The fossæ described in the last vertebra are present in this one, but differ in proportions, owing to the greater size and expanse of the superior parts of the neural arch. The fossa posterior to the base of the diapophysis is nearly plane, while that at the anterior base is deeply excavated, is narrower, and extends so far along the inferior side of the process as to give it a semicircular section near the middle. Distally the diapophysis has a trialate section, owing to its three longitudinal ridges; and the articular extremity is large and antero-posterior in direction. The process differs from that of the vertebra already described, in the possession of a facet near the middle of its anterior inferior bounding ridge, which is probably costal, as in the vertebræ of *Crocodilia*. The lateral foramen of the centrum is subround. The general surface is smooth" *.

The neural arch is confluent with the centrum.

In a later account of the gigantic Saurian † the dorsal vertebræ are again stated to be "remarkable for the enormous elevation of the superior arches and diapophyses, the result of which is to give the ribs an unusually elevated basis, and the cavity of the body much space above the vertebral axis on each side. On the other hand the bones of the tail and limbs are solid or nearly so, in great contrast with some of the Dinosauria of later geological periods. Another peculiarity is the probable great length of the anterior limbs. The scapula is enormous as compared with the pelvic bones. The sacrum is also small and short, showing that the weight was not borne on the hinder limbs." It appears also that *Chondrosteosaurus* resembled *Cetiosaurus* in the "pitted surface of the articular end of the limb-bones."

Reverting to character 2, common to *Chondrosteosaurus* and the Dakota monster, it will be seen that there is a difference of opinion between Prof. Cope and myself as to the contents, in the living giants, of the "huge internal sinuses" of their vertebral centrums. In the Wealden fossils, and, I suppose, also in the Dakota ones, they are occupied by mineral matter derived from the matrix. When Prof. Cops, states

* Pal. Bull. pp. 8, 9.

† 'Proceedings of the American Philosophical Society,' vol. xvii. no. 100, May to December, 1877, p. 233.

"thus the centra of the dorsals are hollow"*, I infer him to mean that, in the recent state, the vertebral sinuses of his reptile, like those in the pneumatic vertebræ of a bird, were filled with air; and he states that "they communicated with the cavity of the body by a foramen on each side"†—meaning, I presume, with such parts of that cavity as were continued from the lungs and contained air. This, indeed, is placed beyond doubt by the term "pneumatic" applied to the lateral fossæ in the dorsal and cervical centrums. On this assumption he affirms, "the vertebræ are lighter in proportion to their bulk than in any air-breathing animal," the cancelli being relatively larger than in the vertebral centra of birds. If, as I believe, the cancelli were occupied by unossified gristle, or "chondrine," and supposing the deficiency of the thin layer of bone at the bottom of the lateral fossæ to be natural, there would be no communication of the cancelli with the cavity of the body or of any viscus therein lodged. The vertebral centra would be solid, although constituted of two tissues, as I conclude to have been the case with those of *Poikilopleuron*, in which the centrum is excavated by a large central cavity or sinus (Pl. X. fig. 5, *ih*), although there are no lateral fossæ ‡. On the other hand the lateral fossæ may exist without cancelli or sinuses in the substance of the centrum, as *e. g.* in *Bothriospondylus suffossus* §. In *Bothriospondylus robustus* ‖ the cancelli are small, numerous, longitudinally extended, ill-defined, wholly unlike the pneumatic cancelli in the vertebræ of birds and Pterodactyles. But the lateral fossæ in extent and depth much resemble those in *Chondrosteosaurus*, and retain their lining of thin compact bone unbroken or imperforate.

In *Cetiosaurus longus* ¶ the lateral fossæ coexist with a closer osseous texture of the centrum than in *Bothriospondylus*; the anterior trunk-vertebræ are opisthocœlian, as in *Chondrosteosaurus*. The lateral depressions at the upper part of the sides of the centrum occasion a "singularly compressed upper portion of such centrum underlying the neural canal and forming a vertical medial plate of bone, three or four inches in height and but six or eight lines in thickness" **; but whatever parts in the thoraco-abdominal cavity may

* Pal. Bull. 1877, p. 5.

† Proc. Amer. Phil. Soc. 1877, p. 233.

‡ Monogr. 1876, pl. i. fig. 3, *ch*.

§ Monograph on the genus *Bothriospondylus* in the volume of the Palæontographical Society issued 1875, pp. 17–20, pls. iv. & v.

‖ Ibid. p. 21, pl. vi. ¶ Ibid. p. 29, pl. x. ** Ibid. p. 30.

occupy or line these depressions, they unquestionably do not convey air into the osseous substance of the vertebra.

In *Omosaurus* also there is a depression on each side of the centrum, in the dorsal vertebræ, "beneath the base of the neural arch" *; but the osseous tissue is as in *Cetiosaurus*. There are no cancelli to communicate with the lateral fossæ.

In the comparison of the vertebræ of *Poikilopleuron*, in which the lateral fossæ are wanting, with those of *Cetiosaurus* and *Omosaurus*, it is noted that "ossification is incomplete and large chondrosal vacuities are left in the substance of the centrum, which, in the fossils, become filled with spar" †.

It seemed reasonable therefore to conclude that in a vertebra combining the lateral fossæ of *Bothriospondylus* with the cancellous texture of *Poikilopleuron* the cancelli, filled with spar in the fossils, might have been occupied by chondrine in the living reptile.

8. *Relative Capacity of the Neural Canal.*

I could not, however, be satisfied with this conclusion or opinion so long as there remained any test to which it might be subjected. It may seem strange that the neural canal should offer such test; but I was attracted to this part of the vertebra for the light it might throw on the point at issue.

All existing air-breathing Vertebrates which have the bony tissue of the centrum cancellous, especially so largely and widely cancellous as in *Chondrosteosaurus* (with which, in this character, birds of flight alone can be compared), and which have such cancelli filled with air, are remarkable for the frequency and vigour of their muscular actions; and such actions, in birds and bats, are correlated with powers of flight.

With this vital energy of the muscular system there is a concomitant development of the nervous system, at least of that division of the central chord which gives origin to the motor stimuli; and the size of the myelon affects that of the neural canal.

To this part, therefore, of the vertebræ of *Chondrosteosaurus* my attention was directed, and, as related in my description ‡, and shown in the figure §, that canal was singularly contracted in proportion to the size of the vertebra (Pl. X. fig. 2, *n*).

A similar narrow neural channel is figured in the view of the anterior trunk-vertebra (copied from Prof. Cope's plate i.

* Monograph on *Bothriospondylus*, Pal. Soc. vol. 1875, p. 48, pl. xii. fig. 3, *f*.

† Ibid. p. 28.

‡ Monogr. cited, Pal. Soc. vol. 1876, p. 6.

§ Ibid. pl. iv. *n*.

fig. 1) in Pl. X. fig. 3, illustrating the present communication. This concordance, indeed, between the Wealden Chondrosteosaur and the Dakota gigantic Reptile may be reckoned as an eighth character and evidence of their generic relationship. In further illustration of this significant indication of the sphere and grade of locomotion in my reptile, I added the figure of a corresponding view of a vertebra of an eagle (Pl. X. fig. 6) *.

It was rather hard, after the pleasurable pains which I had taken to make my few vertebræ as useful as possible to future finders, to have my proposed generic name superseded by *Camarosaurus*, Cope, and still harder to read, in the Professor's excellent supplementary notices of the genus, "Another name (*Chondrosteosaurus*) has been introduced by Prof. Owen; but he specifies no generic characters "†.

A name, notwithstanding Linné's estimate‡, interests me less, in the present case, than the nature and affinities of the gigantic Saurian in question; and towards the latter knowledge Prof. Cope's descriptions give acceptable and valuable aid.

On the limited foundation to this end available in 1876, I was led to refer *Chondrosteosaurus* to the Dinosaurian order, but with a sign of doubt§.

A sacrum, part of a sacrum, perhaps a single sacral vertebra might have dispelled the doubt. Mr. Lucas was so fortunate as to secure the entire sacrum of the Dakota reptile. Its small size and an inference as to its function are noted above. Prof. Cope has added to that notice the following description:—

"It consists of only four vertebral centra, thoroughly coossified. The anterior articular extremity is convex, that of the posterior extremity slightly concave. Its transverse processes are, like those of the other vertebræ, much elevated, although they spring from the centra. The external face of their bases is not prominent; and the spaces between their projecting portions are deeply excavated. The extremities of the adjacent transverse processes are united, thus inclosing large foramina"‖.

In the Dinosaur of the skeleton of which we have the most complete restoration (i. e. *Scelidosaurus*), the sacrum consists of four coalesced vertebræ; the transverse processes are

* Monogr. 1876, pl. iv. fig. 3.

† Bullet. cit. p. 6.

‡ "Nomina si pereunt, periit et cognitio rerum."

§ Monogr. 1876, p. 5—"Order Dinosauria (?)."

‖ Proceedings of the Amer. Philos. Soc. 1867, p. 235.

expanded at their termination, "and thus touch each other, or nearly so, at their ends"*.

A large foramen so enclosed is shown in the figure cited. This characteristic of the Dinosaurian sacrum is more strikingly exhibited in the 5-jointed one of the Iguanodon, in which there are four such large foramina on each side†.

We have thus ground for testing the inference drawn by Prof. Cope, viz. that, with regard to the bulky Saurian of Dakota, "the weight was not borne on the hind limbs." This statement has a meaning on the assumption that the Professor accepts the notion that the previously known Dinosauria, or some of them, marched on their hind legs like birds. What proportion of the weight of *Chondrosteosaurus* might be so sustained we may infer from the analogy of *Scelidosaurus*. Of this Dinosaur both humerus and femur of the same individual are preserved in the specimen now in the British Museum. The relative size of these bones affords an estimate of the share they respectively took in the sustentation and motion of the Saurian on dry land. The femur ‡ is twice the length and more than twice the thickness, in the shaft, of the humerus§.

It may be that well-ascertained specimens of these bones in *Chondrosteosaurus* will exhibit similar proportions.

Prof. Cope, however, writes, "The bones of the tail and limbs are solid or nearly so, in great contrast with some of the Dinosauria of later geological periods. Another peculiarity, of the genus *Camarosaurus* at least, is the probable great length of the anterior limbs. The scapula is enormous as compared to the pelvic bones" ‖. "The great length of the humerus in the probably allied genus *Dystropheus*, from the trias of Utah, adds to the probability that the same bones were large in *Camarosaurus*. This character, taken in connexion with the remarkably long neck possessed by that genus, suggests a resemblance in form and habits between these huge reptiles and the giraffe"¶.

Until, however, a humerus of *Chondrosteosaurus* be unequivocally discovered, it appears to me that the analogy of the dinosaurian *Scelidosaurus* offers safer guidance than the mammalian genus *Camelopardalis*.

* "Monograph on a Fossil Dinosaur," &c., in the Palæontological Society's volume issued 1862, p. 7, pl. vi. fig. 1.

† Owen, 'History of British Fossil Reptiles,' 4to, pt. vi. (1855) pl. 8.

‡ Monogr. 1855, pl. x. 65.

§ Ibid. pl. iii. 53.

‖ Proc. Amer. Philos. Soc. 1877, p. 233.

¶ Ibid. p. 234.

We may assume that the femur of *Chondrosteosaurus* was discovered by Mr. Lucas in such contiguity with the other sufficiently characteristic and previously characterized bones of that genus as to justify the following description of such bone by Prof. Cope:—

"The femur is long and without prominent third trochanter, this process being represented by a low ridge. The condyles have an extensive posterior sweep, and are separated by a shallow trochlear groove in front"*.

In *Scelidosaurus* also the process called "third trochanter" in *Iguanodon* is reduced to, or represented by, a ridge from near the middle of the inner side of the shaft †; and "the condyles are but feebly indicated by a shallow notch on the fore part, but more distinctly behind, where they are produced backward"‡.

In the absence of a figure of the femur of *Chondrosteosaurus*, we may infer that, amongst known Dinosaurs, it most resembled that of *Scelidosaurus*. The main difference is in size. The femur of *Chondrosteosaurus* is, in length, 1820 millims., that of *Scelidosaurus* is 403 millims.

"The tibia of *Chondrosteosaurus*," like that of *Scelidosaurus*, "is much shorter than the femur"§; and "the astragalus is evidently distinct from it"‖, as it is, likewise, in *Scelidosaurus*¶, in which, however, I consider the naviculare and the ento- and mesocuneiform tarsals, in mammals, to have coalesced with the astragalus.

Prof. Cope figures the right scapula of *Chondrosteosaurus*, and gives the following description:—"The scapula is relatively of large size. It is rather elongate, and the superior extremity is expanded. There is a very large mesoscapular process, which is wanting in *Cetiosaurus*, according to Phillips's figures. It appears to resemble the scapula in *Dystropheus*. (See Report of Lieut. Wheeler, vol. iv. pl. lxxxiii. p. 31). The two proximal faces, the glenoid and the coracoid, are well distinguished; and their surfaces are, like the corresponding faces of other bones, pitted coarsely"**.

Besides the scapula of *Cetiosaurus*††, that of *Iguanodon*‡‡ and of *Scelidosaurus* are sufficiently entire to be comparable

* Proc. Amer. Philos. Soc. 1877, p. 236.
† Monogr. 1855, pl. x. 63, *t*.
‡ Ibid. p. 15.
§ Cope, Proc. Amer. Phil. Soc. 1877, p. 236.
‖ Id. ibid.
¶ Monogr. 1855, pl. x. *a*.
** Proc. Amer. Philos. Soc. 1877, p. 235.
†† Monogr. 1875, p. 32, fig. 2.
‡‡ Hist. of Brit. Fossil Reptiles, pt. vi. 1855, pl. 19. fig. 1.

with that of *Chondrosteosaurus*. In *Iguanodon* the breadth of the humeral end is two sevenths the length of the scapula; in *Cetiosaurus* it is not quite one half that length; in *Scelidosaurus* it is one half that length; in *Chondrosteosaurus* it is two thirds that length. In the degree of expansion of the humeral end of the scapula the *Scelidosaurus*, amongst the Dinosauria as known to me, makes the nearest approach to *Chondrosteosaurus*. The part called "mesoscapular process" is not indicated in Prof. Cope's figure. On the supposition that it may be the low ridge there shown, a similar ridge from the middle of the anterior border of the bone is indicated in the scapula of *Scelidosaurus*.

The coarse pitting of the articular surfaces of the limb-bones and arches are most common and best marked in the marine Reptilia (*Ichthyo-* and *Sauro-pterygia*); the degree in which the same character is marked and prevails in the limb-bones of other Saurians points to the predominance of the sea over the land as the theatres of their life-acting. This inference I have drawn and applied to the *Cetiosauri*; it is as legitimate an application in considerations of the way and medium of life of *Chondrosteosaurus*. Not that I deem the Cetiosaurs or any form of Dinosauria to be as exclusively aquatic as the Plesiosaurs; but the degree or proportion of their time passed in water may be inferred from such a character as that noted by Prof. Cope in the articular surfaces of the scapula and in those of the acquired long bones and limb-bones of *Chondrosteosaurus*.

On the pneumatic hypothesis of the cancellous structure of the vertebræ, the conclusion drawn by Prof. Seeley would be equally just and legitimate, viz. that such huge Dinosaurs were "constructed after the lightest and airiest plan, such as is only seen in Pterodactyles and in birds," that the species is "therefore clearly ornithic" and entitled to the designation of *Ornithopsis**.

Prof. Cope, indeed, accepts the consequent inference, viz. that *Chondrosteosaurus* "carried its neck erect after the manner of birds;" but he prefers to compare the reptile, on the assumed concomitant length of a hypothetical humerus, to the giraffe.

As, however, I find the closest resemblance of the parts of the framework of *Chondrosteosaurus*, of which such acceptable additions have been brought to our cognizance through the praiseworthy labours of Prof. Cope and Mr. Lucas†, to those of previously known Dinosauria, it is in that order that I find

* Ann. & Mag. Nat. Hist. 1870, 4th ser. vol. v. p. 279.

† To the latter gentleman the Professor bears the following testimony:—"Credit is due to Superintendent O. W. Lucas for this discovery, and

the most trustworthy and acceptable guides to the true nature and way of life of the stupendous Saurian of the Dakota horizon. As a Bothriospondylian genus the side-pits may have received, as I have suggested, saccular portions of the lung; and the service derived therefrom might be such as the *Gadus navaga* receives by the extension of sacculi of the air-bladder into the excavations of the parapophyses of its abdominal vertebræ—a diminution, viz., of specific gravity facilitating natation.

To the functions with which the further extension of air into the osseous tissue is related, the degree of solidity ascribed to the limbs of *Condrosteosaurus* would be adverse. In that limb-character I see the affinity of the genus to *Cetiosaurus*. In that genus, in *Iguanodon*, and in *Scelidosaurus* the fore limbs manifest the proportions which least impede the faculty of swimming exercised by the powerful hind limbs and tail. From the quantity of unossified tissue in the vertebral column, and from the restriction, as a Dinosaur, of the number of sacral vertebræ, I infer that *Chondrosteosaurus* was more aquatic, less terrestrial, in its life and movements than were the *Iguanodon* and *Megalosaurus*.

It is as interesting as it was unexpected to possess the knowledge of the extensive geographical range of the hugest of the hitherto characterized extinct Reptilia.

As to the geological position of the American representative of our Wealden *Chondrosteosaurus*, Prof. Marsh sees grounds for identifying what is, according to Prof. Mudge, the same horizon as the Dakota with the Wealden of England. But Prof. Cope remarks:—" Specimens from the northern locality which I have examined render it certain that the horizon is that of Mr. Lucas's excavations. Of this I may say that there is no palæontological evidence of its identity with the Wealden. The resemblance of the vertebrate fossils to those of the English Oolite is much greater, but not sufficient as yet for identification. The discovery of Vertebrata in the strata of the Dakota epoch is an important addition to the geology and palæontology of North America "*.

If, however, the legitimate inference from the above detailed conformity of characters between *Chondrosteosaurus* and *Camarosaurus* be accepted, it will supply an evidence of the accuracy of Prof. Marsh's inference as to the Wealden age of the Dakota formation.

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also in an especial manner for the skill and care he has exercised in taking out and shipping the ponderous specimens " (Proc. Amer. Philos. Soc. 1877, p. 234).

* Proc. Amer. Phil. Soc. 1877, p. 234.

Part II. Restoration of *Coryphodon.*

If I were restricted to a single specimen on which to deduce the nature of an extinct animal, I should choose a vertebra to work out a reptile, and a tooth in the case of a mammal.

The characters, seven or eight in number, that may be deduced from a reptilian vertebra have been pointed out in the summary of the subsequent evidences which have contributed towards the reconstruction of the *Chondrosteosaurus.* The dental characters are fewer, yet still, as it has proved, sufficiently significative of the genus founded thereon to guide subsequent discoverers of fossils to a right reference of them.

In the year 1844 a petrified fragment of lower jaw with one entire tooth was dredged up from the sea-bed between St. Osyth and Harwich, off the Essex coast. It came into the possession of John Brown, Esq., F.G.S., by whom it was transmitted to me for determination; and it is now, with the rest of his collections, according to his liberal bequest, in the British Museum. The characters on which the genus of hoofed quadruped was proposed, with the name *Coryphodon*, are detailed in the undercited work*. From the mineral characters of the fossil I inferred that it had been originally imbedded in an Eocene deposit of the Essex coast.

This inference was supported by a second tooth, from a different part of the jaw, which had been brought up in the following year from a depth of 160 feet, out of the plastic clay, in the operations of sinking a well in the neighbourhood of Camberwell. It was submitted to me by Mr. Alport, author of the 'Antiquities and Natural History of the Town of Maidstone in Kent'†.

In the year 1876 Prof. O. C. Marsh, of Yale College, Newhaven, United States, published an account of his discovery, in a formation of the Rocky-Mountain region the horizon of which he determined to be that of the "plastic clay" or lower Eocene of England, of the following remains of a large hoofed quadruped.

The skull lacking the lower jaw, but with the maxillary teeth so preserved as to determine the dental formula to be:—

"Incisors $\frac{3}{3}$, canines $\frac{1}{1}$, premolars $\frac{4}{4}$, molars $\frac{3}{3}$, $\times 2 = 44$"‡.

The last molar and the canine proved the animal to

* 'History of British Fossil Mammals and Birds,' 8vo, 1846, p. 299, figs. 103, 104, 107.

† *Op. cit.* p. 306, fig. 105.

‡ The first notice of this interesting discovery appeared in 'The American Journal of Science and Arts,' vol. xi. May 1876; the more detailed account from which I quote is given in vol. xiv. of the same 'Journal,' July 1877, p. 81.

belong to the same genus as that founded on those teeth in 1846. Other parts of the skeleton included cervical, dorsal, and caudal vertebræ, and, what is still more important and suggestive, the bones of both fore and hind limbs, permitting a restoration of the feet, as in the figures copied in Pl. XI. figs. 1 & 2, from Marsh's memoir *.

In the Section vii. of the undercited work †, containing an attempt to develop Cuvier's idea of the classification of Pachyderms by the number of their toes ‡, I referred the genus *Coryphodon* to the Perissodactyle series. The first confirmation from the limb-bones supplied by the North-American fossils is derived from the femur. I had noted that "the trochanters of the femur are two in the Artiodactyles, but three in the Perissodactyles" §; but at that date I could not apply this proposition to the genus in question. Prof. Marsh writes (1877), "the femur of *Coryphodon* is of the perissodactyl type, and has a distinct third trochanter" ‖.

In my work above cited, when treating of digital characters, I referred to *Coryphodon*, together with *Lophiodon*, *Palæotherium*, *Acerotherium*, and *Hippotherium*, "as links filling up the now broken series of perissodactyle or odd-toed Ungulates represented by the existing genera *Rhinoceros*, *Hyrax*, *Tapirus*, *Equus*" ¶.

But the importance of the link supplied by *Coryphodon* could not have been divined before Prof. Marsh's discovery. This genus, older in time, earlier in date, than *Palæotherium* or *Lophiodon*, retained the digits which they had lost. They are present in what may be termed the mammalian typical number, 5, on both fore (Pl. XI. fig. 1) and hind (ib. fig. 2) feet.

A form of hoofed limb may yet be discovered (and I should expect it in the predecessors of the Hyracotherioids) of a more generalized type than that in *Coryphodon*—one, viz., in which the perisso- or the artio-dactyle characters will be less distinctively marked.

It is not that the greater robustness of the third metapodial indicates the tendency to perissodactylism; for such is the character of that bone in the artiodactyle *Hyopotamus*. The third metatarsal (second through loss of the first) differs both by breadth and length from the fourth metatarsal, to which it

* *Tom. cit.* pl. iv.

† 'Contributions to the History of the British Fossil Mammals,' 4to, 1848, p. 30.

‡ See 'Ossemens Fossiles,' tom. iii. ed. 1822, 4to, p. 72.

§ Contributions &c. p. 59.

‖ *Loc. cit.* p. 83.

¶ *Loc. cit.* p. 55.

becomes equal and similar in later Artiodactyles. But in *Coryphodon* a superior size of the third digit coexists with a three-trochantered femur. I therefore limit myself to tracing the subsequent simplifications of the foot in the Perissodactyle series.

As these Ungulates approach the present time the feet gain in length but lose in breadth; and the latter loss is due not only to proportions of the constituent bones of the fore and hind feet, but to disappearance of digits.

The first or innermost is always the first to go.

Two series, however, may be traced, in which the tendency to length over breadth of foot is more marked in one than in the other. The broader type is represented in the still living series by the rhinoceros, the narrower type by the horse.

The earliest, now extinct, form of *Rhinoceros*, called, from the non-development of the defensive weapon, *Acerotherium*, exhibits the type of fore foot shown in fig. 4.

Its diminutive congener (*Hyrax*), which escapes an enemy by hiding in the cavities of rocks, is also hornless, like the old Tertiary Acerothere, and retains a similar type of four-toed fore foot. With the coming in of enemies in the later Miocene and Pliocene periods the formidable horn is developed in the larger beasts, single or two in number, and these one behind the other, never in a pair; although elevations of the outer table of the skull, simulating horns, do occur, in a symmetrical pair, in some species of Acerothere. The contemporaries of the tiger in India, and of the lion in Africa, superadd to their weapon of attack defensive armour, in the thickness of their folded hide. The foot of the modern rhinoceros is reduced, as in Pl. XI. fig. 5, to the tridactyle type; but a rudiment of the fifth metapodial (ib. v) is still retained. The divergence from the pentadactyle type in the longer and narrower form of foot can now be traced through a rich series of gradations *, of which three are selected for the present illustration. In Pl. XI., fig. 6 represents the fore foot of the *Orohippus*, in which the first digit alone is wanting. The relative size of the third indicates the superior share it takes in station and progression. The persistence of the fifth digit, though slender, adds to the power which *Orohippus* possessed to pass over swamps, in which the foot of the modern horse would sink.

In the Miocene Hippothere (ib. fig. 7) the fifth digit has gone, and the second and fourth are reduced, while the third is enlarged. It is a form of foot better adapted than that of *Orohippus*

* For a knowledge of which we are chiefly indebted to Prof. Marsh, "Notice of new Equine Mammals from the Tertiary Formation," in Amer. Journal of Arts and Sciences, vol. vii. March 1874.

for swiftness. In the Pliocene and existing Equines (horse, ass, zebra) the phalanges of the second and fourth have ceased to be developed, and their metapodials (ib. fig. 8, II & IV) are reduced to the farrier's "splint-bones;" growth has been concentrated on the third digit. With this simplified form of foot speed is maximized and escape from enemies best assured. The safety of no antecedent Perissodactyle was so provided for. The strategy of Equines is retreat rather than combat; if driven to defence, the single hoof on the hind foot is launched out at the assailant.

As a general rule, it may be remarked that no Eocene hoofed mammal bears weapons; the canines are small when recognizable, so small in some as to have suggested to their discoverer the name "*Anoplotherium*," or weaponless. Partial elevations of the outer table of the skull, analogous to the nasal pair in an old Miocene hornless *Rhinoceros**, are developed in pairs on other parts of the skull, even on the mandible (*Dinoceras* e. g.). It is most probable that these large and low obtuse prominences, like the pair in *Acerotherium pleuroceros*, Duv., and the median one in *Camelopardalis*, were covered with hairy or callous tegument, not capped with horn: they cannot be cited as "weapons." One of these singular mammals, the *Dinoceras mirabile* of Marsh, from the "Eocene of Wyoming," offers the exceptional instance of a pair of upper canines descending, like those of *Machairodus* and *Trichechus*, outside and beyond the lower border of the mandible.

But the character which is exceptional in the oldest Tertiary Ungulates becomes the rule in the newest ones and in existing species. The Rhinoceroses, *e. g.*, have their mesial horns, the Ruminants their parial ones, the Boars their horn-like tusks; and this better-weaponed condition of herbivorous objects of prey seems to be correlated with concomitant increase in number, size, and force of their carnivorous enemies.

At the Eocene period Carnivores appear to have been but few and not large. The *Hyænodon* of Hordwell and of the Eocène supérieure du Gard, the *Pterodon* and *Cynodon* of the Lignites of Débruge, the *Arctocyon* of the Eocène inférieure à la Vère, the *Galethylax* of the Paris Gyps, the *Rhagatherium* of the Eocene of Mauremont did not acquire the size of a panther. The species of *Amphicyon* and *Hyænarctos* make their appearance at the Miocene period, but are mostly inferior

* "C'est du *Rhinoceros minutus*, G. Cuv., qu'il faut rapprocher un rhinocéros du Bourbonnais que M. Duvernoy supposait avoir deux cornes placées l'une à côté du nez et l'autre de l'autre côté" (Ossem. Foss., ed. posthum., 8vo).

in size to the later bears, lions, and tigers. The acquisition of the most perfect and distinctive carnassial organization, as exemplified in *Felis* proper, has not been manifested with certainty by fossils from formations older than those of Miocene age; and there they are rare and do not exceed the Jaguar in size (e. g. *Machairodus*, Kaup; *Felis cristata*, Cautley and Falc.). As Pictet well observes of the Carnassiers, "Ils ont, pendant les premiers âges du développement des mammifères, été précédés par des espèces plus faibles, plus lentes et plus omnivores"*.

The modifications at present traceable in the Perissodactyle division of hoofed mammals pass, as we have seen, in two directions—one supplying the species with means of defence and combat by thick hides and true horns, the other perfecting their means of escape by increased speed.

In connexion with the elephantine proportions, feet, and excessive development of an upper pair of tusks of *Dinoceras*, new interest is attached to the partial risings of the outer table of the skull in certain Miocene Proboscidians. In *Elephas hysudricus* the frontal pair, with their broader bases, are divided by a channel; in *E. namadicus* the coalesced bases of the frontal risings project forward. One cannot call these developments "horns," any more than the pair of bosses which modify the lower contour of the mandibular rami of the *Megatherium*, like the similar developments in *Dinoceras*. True horns, or keratose weapons, are pointed, whether they consist of bone only or of both osseous and corneous substances; and when branched, as a rule, the snags are pointed.

Cuvier first noted the relative inferiority of size and simplicity of surface of the brain in a large herbivore of the Eocene period (*Anoplotherium commune*), whence he deduced the inference that it must have been but poorly endowed with intelligence. The probable or possible conditions of such relative stupidity are not entered upon. In a beast of the size of an ordinary ass, the brain was hardly so large as that of a roebuck†.

Gratiolet‡ noted a similar simplicity of cerebral structure in the *Cainotherium* of the lower Miocene of Allier, France.

* Traité de Paléontologie, 8vo, 1853, vol. i. p. 226.

† "Un hasard heureux m'a aussi procuré quelque idée de la forme du cerveau dans l'*Anoplotherium*—il étoit peu volumineux à proportion, aplati horizontalement: ses hémisphères ne montroient pas des circonvolutions, mais on voyoit seulement un enfoncement longitudinal peu profond sur chacun. Toutes les lois de l'analogie nous autorisent à conclure que notre animal étoit fort dépourvu d'intelligence."—*Ossemens Fossiles*, 4to, ed. 1822, tom. iii. p. 44, pl. vii. fig. 3.

‡ Bullet. de la Société Philomathique, Février 1858.

In the fossil skull of a herbivore from an older division of the Eocene ("l'éocène à Lophiodons" d'Issel), Ed. Lartet* found the brain, as represented by the cast in matrix, to be still less, relatively, than in the Anoplothere and Cainothere. The hemispheres extended neither upon the rhinencephalon in front nor upon the cerebellum behind. He also notes the lower development of the brain in the Miocene *Hipparion* as compared with that of a modern *Equus* of similar bulk. Referring to the size of the much-convoluted cerebral hemispheres of the brain in the elephant, and assuming the natural duration of life of that animal to be 150 years, associating also the longevity of Man with his large brain †, Lartet infers that the older the mammal in geological time the briefer was the life of the individual and the smaller the amount of its intellectual faculties ‡.

When, however, we consider the small size of brain and the great length of life of a gigantic tortoise, the correlation supporting the induction of the briefer life-periods of the individual herbivores of the Miocene and Eocene periods is far from commending itself to credence. As to the limitation of intelligence associated by Gratiolet and Lartet, as by Cuvier, with the low development of brain, that is the obvious physiological inference.

The question, which is here left untouched, is, What were the conditions of existence in the older tertiary times which rendered better brains and concomitant intelligence uncalled for in the peaceful Herbivora of those periods?

To the attempt to solve this question I was led by observing that an Eocene marine mammal showed the same inferiority of development of its cerebral hemispheres, compared with its modern congeners, as did the terrestrial forms §. And the

* Comptes Rendus de l'Acad. des Sciences, Juin 1868.

† "L'éléphant, qui vit un siècle et demi, a le cerveau plus grand qu'aucun autre mammifère terrestre; après l'éléphant viendrait l'homme qui, par le volume absolu du cerveau, comme par la longévité, parait l'emporter sur les autres mammifères terrestres."—*Loc. cit.*

‡ "Il en ressortirait comme hypothèse explicative des faits observés, que, dans certains divisions de la classe des mammifères, il y aurait eu, depuis leur apparition sur le globe, accroissement graduel d'énergie vitale et d'intelligence; en termes plus explicites, que la durée de vie et le développement des facultés intellectuelles auraient été moindres chez les espèces fossiles remontant aux premiers temps de la période tertiaire que leurs analogues ou leurs congénères de l'époque actuelle."—*Loc. cit.*

§ "Viewing fig. 2 (brain of *Eotherium*) in contrast with fig. 5 (brain of *Manatus*), one is led to speculate on the circumstances influencing increase of brain-mass in marine mammals of simple, sluggish, Sirenian habits, either obtaining their food from seaweed at no great depth, or shuffling along to browse the grassy shore of a river or estuary. Certain it is that since the good old Eocene times 'new foes have arisen;' and any explanation which I hazarded I believed might apply to analogous instances in time-series of other and terrestrial herbivorous mammals.

The Coryphodons may have roamed over the regions of Utah, Wyoming, and New Mexico in vast herds; but they were not harried and disturbed by the enemies that now persecute the bisons of North America. The instincts which such unintermitting persecution have developed in the wild Herbivora of that and other continents, and which call for the utmost skill and wood-craft of the sportsman to circumvent, were little, if at all, excited in the oldest Eocene period, so far as the evidences of contemporary enemies of *Coryphodon* have come to light.

"The brain-cavity in *Coryphodon*" (Pl. XI. fig. 3, *e*, *p*, *r*), writes Prof. Marsh, "is, perhaps, the most remarkable feature in the genus, and indicates that the brain itself was of a very inferior type; but its most striking modifications are the small size of the hemispheres [*p*] compared with the expanded cerebellum [*e*]. The olfactory lobes [*r*] were large and entirely in advance of the hemispheres" *.

Thus the parts of the brain which experimental physiology has associated with the locomotive function and the testing of food, were present in due proportion to the bulk of the extinct Herbivore. The quest of favourite foliage and delicate herbage by the exercise of an acute sense of smell, and the migrations from pasture to pasture or from grove to grove, were both provided for in their relations to the cerebral organization. But the superadded mass which converts the sensations into ideas, and retains the impressions as memories, remained at that low stage of development which suited a blissful condition of existence untroubled by the necessity of taking cognizance of, and contriving escapes from, the attacks and wiles of creatures concerned in killing Coryphodons.

To the close and careful comparisons of the conscientious palæontologist of Yale College we are indebted for the above interesting and unexpected additions to our knowledge of the rare and ancient Tertiary mammal, fragmentarily indicated

increase in the number of creatures and their lethal powers concerned in killing sea-cows would add to the number of phenomena which such sea-cows were concerned in noting, with concomitant reaction of such perceptions, or neural vibrations, resulting in a change of cerebral into muscular force, exercised to put themselves into depths of safety. With such augmentation of ideas the thinking-organ has grown." ("On *Eotherium ægyptiacum*," Quarterly Journal of the Geological Society, 1875, vol. xxxi. p. 105.)

* Marsh, *loc. cit.* p. 82.

in the "plastic clay" of England (1845), and in the "conglomérate de l'argile plastique" at Meudon, France (1856) *, of the elements toward a restoration of which we might have long remained in doubt had they continued to be made known to us as parts of a *Bathmodon* or *Loxolophodon* †.

EXPLANATION OF THE PLATES.

Plate X.

Fig. 1. Under view of anterior trunk-vertebra (one fifth nat. size) of *Chondrosteosaurus.*
Fig. 2. Upper view of the same vertebra (one fifth nat. size) of ditto.
Fig. 3. Upper view of a similar, but more mutilated, vertebra (much reduced) of ditto (after Cope).
Fig. 4. Side view of a dorsal vertebra (after Cope), much reduced, of ditto.
Fig. 5. Longitudinal vertical section of a dorsal vertebra of a *Poikilopleuron.*
Fig. 6. Longitudinal horizontal section of a cervical vertebra of an eagle (*Haliæetus albicilla*).

Plate XI.

Fig. 1. Bones of the left fore foot, *Coryphodon* (after Marsh, much reduced).
Fig. 2. Bones of the left hind foot, *Coryphodon* (ditto, ditto).
Fig. 3. Outline of skull and cerebral cavity, *Coryphodon* (ditto, ditto).
Fig. 4. Bones of the fore foot, *Acerotherium* (reduced).
Fig. 5. Ditto, *Rhinoceros* (reduced).
Fig. 6. Ditto, *Orohippus* (ditto).
Fig. 7. Ditto, *Hipparion* (ditto).
Fig. 8. Ditto, *Equus* (ditto).

XXV.—*Characters of undescribed Species of* Halticinæ. By Joseph S. Baly, F.L.S.

[Continued from ser. 5, vol. i. p. 322.]

Œdionychis bitæniata, Clark, MS.

Œ. subelongato-ovata, postice paullo ampliata, convexa, pallide flava, femoribus posticis apice, scutello elytrisque (his basi exceptis) nigris; elytris crebre, sat fortiter punctatis, cyaneis, limbo

* Hébert, 'Annales des Sciences Nat.' t. vi. p. 87, pls. iii. and iv. (1856).
† "The Museum of Yale College contains a large collection of *Coryphodon* remains from Utah, Wyoming, and New Mexico; and this material is amply sufficient to indicate all the more important characters of the group. Among these specimens are portions of the same individuals described by Cope under the names *Bathmodon* and *Loxolophodon*, both of which are synonyms of *Coryphodon*" (Marsh, American Journal of Science and Arts, vol. xiv. July 1877, p. 81).

laterali a basi ad medium, fascia lata prope medium, altera ante apicem limboque inflexo pallide flavis.

Long. 4–5 lin.

Hab. Brazil.

Head short, trigonate; vertex and front coarsely punctured on the sides; encarpæ transverse, bounded above by a deep depression; carina ill defined, broad, trigonate, terminating below on the usual transverse ridge; eyes rotundate, ovate, not sinuate within; antennæ about half the length of the body, filiform, the second joint ovate, the third and fourth equal, each more than half the length of the second; three lower joints flavous, the rest black. Thorax nearly three times as broad as long; sides broadly dilated, reflexed, parallel at the base, thence rounded and converging to the apex, the latter armed with an obtuse, very slightly excurved tooth; disk very minutely and distinctly punctured, faintly impressed in front of the basal margin with an ill-defined transverse groove, also indistinctly sulcate on either side just behind the apical margin; dilated margin concave, its surface irregular. Scutellum regularly trigonate, shining black, its surface granulose. Elytra broader than the thorax, ovate, slightly dilated posteriorly, closely and deeply punctured, lateral margin narrowly dilated, reflexed. Hinder claw strongly thickened, nigro-piceous. Prosternum narrow, elongate, its apex subspatulate.

Œdionychis elegans.

Œ. late ovata, convexa, pallide rufo-picea, nitida, antennis extrorsum nigris; elytris cyaneo-nigris, sat fortiter punctatis; utrinque vittis duabus latis, basi et apice conjunctis, prima submarginali, secunda discoidali, a basi ad medium intus curvata, hinc ad apicem ad suturam parallela, flavis ornatis.

Long. 3 lin.

Hab. Bahia. Collected by Mr. Edwin Reed.

Head trigonate; vertex smooth, impunctate; front excavated above the encarpæ, impressed with large round punctures; encarpæ subquadrate; carina ill defined, wedge-shaped; antennæ scarcely half the length of the body, the second joint ovate, the third, fourth, and fifth nearly equal, the two latter rather longer than the third, the sixth and five following joints shorter, each nearly equal in length to the third, the five upper ones slightly thickened, black. Thorax three times as broad as long; sides broadly dilated, straight and nearly parallel from the base to beyond the middle, thence rounded and converging to the apex; apical angle thickened, armed with a short, excurved, acute tooth; upper surface finely but not closely punctured; lateral margin reflexed, concave, its outer edge thickened. Elytra broader than the thorax, very broadly ovate, convex, closely punctured, shining black with a metallic-blue tint; each elytron with two broad pale yellow vittæ, confluent at base and apex, one submarginal, the other commencing on the shoulder and curving obliquely downwards and inwards as far as the middle of the elytra, from which point it runs parallel and close to the suture as far as the apex, where it joins the submarginal vitta. Hinder thigh strongly thickened; hinder tibiæ shorter than the femora; claw-joint of hinder tarsus strongly inflated.

Œdionychis seriata.

Œ. anguste ovata, convexa, subtus piceo-flava, supra flava, nitida, capite (antennis extrorsum nigris exceptis) scutelloque piceis; elytris tenuiter, crebre punctatis, sutura utrinque, apice extremo maculisque elongatis 8 (his in lineis longitudinalibus duabus, quarum una submarginali, altera discoidali, seriatis) piceis.

Long. $3\frac{1}{2}$ lin.

Hab. Guatemala.

Vertex smooth and shining; face between the eyes, together with the upper orbits of the latter, impressed with large round punctures; encarpæ smooth, subquadrate, bounded above by a deep transverse depression, from the middle of which a longitudinal groove runs upwards to the vertex; carina narrowly wedge-shaped, terminating below on a strongly raised transverse ridge; antennæ filiform, half the length of the body, the second joint ovate, the third and the following four joints nearly equal in length, each more than one half longer than the second; four lower joints piceo-fulvous, the rest black. Thorax nearly three times as broad as long; sides broadly dilated, reflexed, nearly straight and parallel from the base to the middle, thence rounded and converging to the apex, the anterior angle armed with a short excurved tooth; disk minutely and rather distantly punctured, the punctures only visible with a strong lens; lateral margin concave. Scutellum as broad as long, trigonate. Elytra oblong, rather closely punctured, the punctures pale piceous; convex, the lateral margin only moderately dilated, reflexed; each elytron with a narrow sutural line, the extreme apical margin and eight narrow elongate piceous spots arranged in pairs, two at the base, two before and two beyond the middle, and lastly two subapical; these spots form two longitudinal rows, one placed close to the outer margin and the other on the middle disk. Hinder thighs strongly thickened; apical joint of hinder tarsus strongly inflated.

Œdionychis posticata.

Œ. ovata, convexa, nitida, subtus flavo-fulva, thorace utrinque macula pedibusque posticis piceis, supra piceo-nigra, fronte, labro antennisque pallide piceis, his basi flavis; thorace minute punctato, tenuiter granuloso-strigoso, basi pallide picea, lateribus explanatis flavis; elytris læte fulvo-testaceis, minute punctatis, fascia lata communi pone medium, fere ad apicem extensa, nigra, apice extremo flavo.
Long. $2\frac{1}{2}$ lin.

Hab. Amazons. Collected by Mr. Bates.

Head trigonate; vertex and front smooth, impunctate, the latter depressed anteriorly; encarpæ prominent, transverse-quadrate; carinæ strongly raised and thickened between the bases of the antennæ, terminating below on a strongly raised transverse ridge; eyes large, prominent, slightly sinuate along the inner border; antennæ rather slender, filiform, more than two thirds the length of the body; second joint oblong, third and following five nearly equal, each about one half longer than the second; three lower joints pale yellow, the fourth to the eighth inclusive nigro-piceous, the three upper ones pale piceous. Thorax more than twice as broad as long; sides broadly dilated, reflexed, rounded and converging from base to apex, the anterior angles armed with an excurved setiferous tooth; disk transversely convex, very finely granulose-strigose, very minutely punctured; reflexed lateral margin concave, pale yellow; basal margin pale piceous. Scutellum piceous. Elytra broader than the thorax, broadly ovate, convex; the outer margin narrowly dilated, reflexed; surface minutely punctured, very finely strigose, bright testaceo-fulvous; a broad common fascia, commencing a short distance below the middle of the disk and extending nearly to the apex, black; the apex itself pale yellow. Hinder thighs strongly thickened; hinder claw-joint strongly dilated.

Œdionychis crassa, Clark, MS.

Œ. late ovata, valde convexa, subtus cum capite nitida, pallide rufo-picea, pleuris piceo-nigris; supra opaca, sordide flava, scutello antennisque (his basi exceptis) piceo-nigris; thorace fortiter punctato, lateribus obliquis, apice mucronatis; elytris fortiter punctatis, utrinque vitta piceo-nigra discoidali, a basi ad longe pone medium producta, instructis.
Long. 4 lin.

Hab. Brazil.

Head subrotundate, coarsely rugose; encarpæ transverse, thickened; carina thickened, trigonate, ill defined, terminating below on the usual transverse ridge; antennæ robust, the three lower joints rufo-piceous, the rest nearly black. Thorax more than twice as broad as long at the base; sides obliquely converging and nearly straight from the base to beyond the middle, thence rather more quickly converging to the apex, the latter armed with a short, obtuse, slightly excurved tooth; upper surface coarsely and closely punctured; lateral border moderately dilated, recurved, its surface concave, rugose. Scutellum trigonate, as broad as long. Elytra deeply, coarsely, and closely punctured, the outer margin only narrowly dilated, reflexed; each elytron with a narrow pitchy-black vitta, which, commencing at the base, runs down the inner portion of the outer disk and terminates about halfway between the middle and the apex. Hinder thigh strongly thickened, hinder tibia very short; apical joint of hinder tarsus strongly inflated, nigro-piceous.

Œdionychis natalensis.

Œ. ovata, postice paullo ampliata, valde convexa, sordide fulva, minus nitida, subtus nitida, pectore abdomineque piceis, tibiis (basi excepta), tarsis antennisque (his basi exceptis) nigris; thorace granuloso, subcrebre, evidenter punctato, lateribus fere rectis, a basi ad apicem convergentibus; elytris fortiter, sat crebre punctatis, interstitiis minute punctatis.

Long. 4 lin.

Hab. Port Natal.

Head coarsely rugose-punctate; encarpæ transverse-quadrate, contiguous, bounded above by a deep transverse depression; carina raised, wedge-shaped, its apex acuminate, its lower extremity terminating on a strongly raised transverse ridge, which extends entirely across the lower portion of the clypeus; antennæ filiform, the three lower joints, together with the basal half of the fourth, fulvous, the rest black. Thorax more than twice as broad as long; sides nearly straight, obliquely converging from base to apex, the anterior angles submucronate; basal margin very obtusely rounded, sinuate on either side near the outer angle, the latter slightly produced, very acute; disk granulose, distinctly but not coarsely punctured; median line with a faint longitudinal groove; lateral border broad, reflexed, its surface irregular. Scutellum trigonate, smooth, impunctate. Elytra broader than the thorax, broadly oblong-ovate, convex, coarsely punctured, the interspaces nitidous, impressed with minute punctures. Hinder femora strongly thickened. Basal joint of hinder tarsus about equal in length to the second; claw-joint strongly inflated.

Œdionychis Germari.

Œ. late ovata, convexa, nigra, nitida, facie inter oculos, macula utrinque antennisque basi piceo-fulvis; thorace albido, fascia pone apicem, utrinque abbreviata, nigra; elytris distincte, subfortiter, punctatis limbo exteriore, fascia mediana nec non sutura inter fasciam et apicem albidis.

Long. $3\frac{2}{3}$ lin.

Hab. Bahia.

Head short; vertex and front shining, impunctate; encarpæ transverse-quadrate, bounded above by a deep transverse depression; carina thickened, narrowly wedge-shaped, terminating anteriorly on a strongly raised transverse ridge; antennæ filiform, three lower joints piceo-fulvous, the rest black, third nearly twice as long as the second, scarcely more than half the length of the fourth. Thorax nearly three times as broad as long; sides broadly margined, rounded and converging from base to apex, the anterior angles produced, mucronate; disk minutely punctured, lateral margin reflexed, concave. Scutellum trigonate, its apex rounded. Elytra broader than the thorax, moderately convex, the lateral margin rather broadly dilated; surface distinctly and rather deeply but not coarsely punctured, the interspaces between the punctures minutely punctured. Tarsi nigro-piceous; basal joints of hinder tarsus equal in length to the second; claw-joint strongly dilated.

The broadly oval form will at once distinguish this insect from any similarly coloured species.

Œdionychis spilota.

Œ. elongato-ovata, modice convexa, nitida, subtus nigra, prothorace pedibusque flavis, femoribus tibiisque apice tarsisque nigris; supra flava, vertice antennisque (his basi exceptis) nigris; thorace lateribus late explanatis, rotundatis, disco lævi, fascia basali, utrinque abbreviata, nigra; scutello nigro; elytris minute, crebre punctatis, utrinque maculis quatuor nigris, duabus infra basin transversim positis, prima elongata super callum humerale, secunda inter callum et suturam, subovata, tertia prope medium, magna, transverso-quadrata, quartaque trigonata ante apicem positis.

Long. 3 lin.

Hab. Rio Janeiro. Collected by the late Mr. Squire.

Head trigonate; encarpæ subquadrate, contiguous, bounded above by a deep transverse groove; lower border of clypeus, labrum, jaws, and cheeks nigro-piceous; eyes black; antennæ filiform, third joint twice the length of the second, four lower joints fulvous, the rest black. Thorax twice as broad as long; sides straight and parallel from the base to the middle, thence obliquely rounded and converging to the apex, the latter produced, thickened, subacute; hinder angles acute, mucronate; disk transversely convex, minutely punctured; lateral margin sroad, reflexed, its surface concave. Scutellum transverse, tubtrigonate, its apex broadly rounded. Elytra broader than he thorax, oblong-ovate, above moderately convex, more coarsely punctured than the thorax, the punctures pale piceous; lateral margin moderately dilated, slightly reflexed. Basal joint of hinder tarsus equal in length to the second.

Disonycha fenestrata.

D. elongato-ovata, modice convexa, nitida, subtus fulva, pectore, abdomine femoribusque posticis nigris; supra nigra, antennis thoraceque fulvis, hoc tenuissime punctato, basi leviter transversim sulcato; elytris distincte punctatis, utrinque plaga magna oblongo-quadrata flava, medio fascia interrupta nigra notata, ornatis.
Long. 3 lin.

Hab. Columbia.

Head shining, impunctate; antennæ with the three lower joints stained above with piceous. Thorax nearly twice as broad as long; sides straight and nearly parallel, slightly bisinuate, the hinder angles produced, acute. Elytra narrowly oblong, distinctly punctured; each with a large oblong-quadrate pale yellow patch, which extends from just before to some distance below the middle of the elytron, and from side to side nearly to the sutural and lateral margins; on its surface are several irregular black spots which form an interrupted transverse band across its middle.

Systena Oberthuri.

S. elongata, modice convexa, pallide viridis, nitida, oculis nigris, antennis extrorsum pallide piceis; thorace tenuiter punctato; elytris thorace paullo latioribus, parallelis, sat crebre substriatim punctatis, vitta suturali, pone medium abbreviata et utrinque maculis tribus, una super callum humerale, oblonga, secunda prope medium, trigonata, tertiaque ante apicem subrotundata, piceis.
Long. 3 lin.

Hab. Matachin, Panama. Collected by Dr. O. Thieme.

Vertex minutely and remotely punctured, front impressed in the middle with a small fovea; encarpæ trigonate, contiguous; eyes rotundate, black; apex of jaws nigro-piceous; antennæ slender, filiform, more than three fourths the length of the body, the seven outer joints pale piceous. Thorax one half broader than long; sides constricted and sinuate behind the middle, converging in front, the anterior angles obtuse; surface finely punctured, impressed on either side at the base with an indistinct perpendicular groove; placed transversely between these grooves are several faint ill-defined foveæ. Elytra rather broader than the thorax; sides parallel; disk moderately convex, more strongly and closely punctured than the thorax, the punctures closely arranged in longitudinal striæ; each elytron with a narrow sutural line, abbreviated below the middle, and three large spots on the disk, piceous: of these spots one, oblong, is placed on the humeral callus, the second, trigonate, has its base on the junction of the outer margin with the disk, its apex extending nearly to the suture, and the third, subrotundate and subapical, is larger and better-defined than the two others; on the outer edge of the disk, connecting the two anterior spots, is a nearly obsolete longitudinal piceous line.

The above description is drawn up from a single specimen, kindly sent me by M. Oberthur; but it is more than probable that the piceous markings on the elytra vary in extent, and that some individuals may be found in which the elytra are piceous, with the outer limb and three spots on each elytron pale green.

Prasonia Haroldi.

P. elongata, modice convexa, subtus cum scutello picea, prothorace prasino, capite sordide fulvo, viridi tincto, antennis extrorsum piceis; thorace leviter ruguloso, distincte punctato, ante basin leviter transversim sulcato, prasino, basi et apice flavo marginato; elytris thorace vix latioribus, ad apicem paullo attenuatis, sat crebre punctatis, viridi-flavis, utrinque disco prasino suffuso, linea suturali alteraque marginali, ante apicem abbreviatis, piceis.
Long. $3\frac{1}{2}$ lin.

Hab. Paraguay.

Head exserted; vertex finely punctured; face swollen between the eyes; encarpæ pyriform, contiguous; labrum shining black, narrowly edged with flavous; antennæ about three fourths the length of the body, moderately robust, scarcely attenuated towards the apex. Thorax nearly twice as broad as long; sides rather broadly margined, straight and slightly diverging from the base to beyond the middle, thence rounded and converging to the apex, the hinder angles distinct, the anterior ones slightly produced, obtuse; upper surface moderately convex, impressed in front of the base with a transverse groove; surface finely rugulose, rather coarsely punctured; the colour is pale green, obsoletely bordered at base and apex with greenish yellow. Scutellum transverse, its apex broadly rounded. Elytra scarcely broader than the thorax, slightly attenuated towards the apex, convex, not depressed transversely below the basilar space, from the base to beyond the middle faintly depressed longitudinally along the suture, more finely punctured than the thorax, greenish yellow; a large longitudinal patch on the disk of each elytron, covering nearly its whole surface, but attenuated at the base, pale green; each elytron with two narrow piceous lines, commencing at the base and abbreviated below the middle, one placed on the suture and the other on the lateral margin.

The broad thorax gives this species an entirely different aspect to the typical form of the genus; but I cannot find any essential structural difference.

Phygasia dorsata.

P. ovata, convexa, nigra, nitida; elytris fulvis, apice plagaque magna discoidali communi nigris, utrinque vittis elevatis tribus, basi et apice abbreviatis, exteriore pone medium fracta et ramulum brevem introrsum emittente, instructis.

Long. $3\frac{1}{4}$ lin.

Hab. India, without precise locality, my collection; Kasia hills, coll. Chapuis.

Vertex smooth, impunctate; encarpæ subpyriform, contiguous; carina narrow, elongate; antennæ more than two thirds the length of the body, filiform, three or four lower joints piceous, the rest black. Thorax nearly twice as broad as long; sides broadly margined, reflexed, rounded, converging towards the base, the anterior angles produced, thickened, obtuse; basal groove deeply impressed, terminated on either side by a deep fovea; disk smooth, impunctate. Elytra oblong-ovate, broader than the thorax, attenuated towards the apex, the latter subacute, slightly recurved; surface minutely punctured, each elytron with three longitudinal ribs; of these the outer one commences on the humeral callus, and extends three fourths the length of the elytron; the second commences just below and rather within the humeral callus, and runs parallel to the outer rib, terminating at about the same distance from the apex of the elytron, the third or inner one is placed on the line of junction between the inner and outer disks, and is much shorter than the two others, commencing considerably below the base, and terminating at a short distance below the middle; the outer rib below its middle is more or less distinctly interrupted, sending a short ill-defined ramus towards the intermediate rib; lastly, parallel to the suture at its apex is a raised longitudinal line: commencing just before the middle of the disk and extending nearly to the black apex is a large common shield-shaped black patch, its anterior margin transversely truncate, and its hinder apex acuminate.

Arsipoda Erichsoni.

A. elongato-ovata, convexa, nigra aut nigro-picea, nitida, thorace, pedibus antennarumque basi obscure rufis; thorace sat crebre, subfortiter punctato, sulco basali integro, sat fortiter impresso; elytris cupreo tinctis, fortiter punctato-striatis, interstitiis obsolete convexiusculis, leviter transversim rugulosis, distincte punctatis.

Var. A. thorace nigro-piceo.

Long. 2 lin.

Hab. Tasmania. The type in my collection and that of Dr. Chapuis; var. A in my own cabinet.

Head impressed on either side above the eye with a few deep foveæ; encarpæ subquadrate, oblique, their inner angles contiguous; carina thickened, elongate; antennæ rather more than half the length of the body, filiform, the four lower joints obscure rufous, the rest nigro-piceous or entirely black. Thorax twice as broad as long; sides straight and nearly parallel from the base to the middle, thence obliquely converging to the apex, the anterior angles produced, thickened, obtuse, the hinder ones nearly rectangular; basal margin transversely truncate on either side, the median lobe produced, obtusely rounded; upper surface rather closely punctured, more or less stained on the disk with piceous; basal groove deeply impressed, entire, bounded on either side by a perpendicular impression. Elytra narrowly oblong-ovate, rather broader than the thorax, coarsely punctate-striate, the interspaces faintly wrinkled, distinctly punctured. Hinder femora unarmed; hinder tibiæ about equal in length to the femora, slightly curved and slightly sulcate on the upper edge; basal joint of all the tarsi dilated in the male.

Myrcina spectabilis.

M. late ovata, convexa, sordide fulva, nitida, antennis (basi picea excepta) scutelloque nigris; thorace transverso, basi transversim sulcato, sat fortiter punctato, sulco basali et utrinque macula subapicali nigris; elytris crebre punctatis, viridi-cyaneis, apice fulvis.

Mas antennis corpore paullo longioribus; *femoribus* intermediis sat valde incrassatis, subtus ante apicem angulatis; *tibiis* anticis compressis, apice incurvatis et spina brevi conica armatis.

Fœm. antennis corpore multo brevioribus; *femoribus* intermediis modice incrassatis.

Long. 4½–5 lin.

Hab. Madagascar.

Head exserted, perpendicular; face swollen between the eyes; carina raised, linear, and extending downwards on the surface of the trigonate clypeus in the form of a longitudinal ridge; encarpæ transverse, contiguous, separated from the front by a deep transverse groove; eyes distant, oval; antennæ with the three lower joints pale piceous, the rest black. Thorax twice as broad as long; sides reflexed, slightly rounded, nearly parallel, the anterior angles produced, very obtuse; upper surface impressed at the base with a broad transverse groove, which extends on either side nearly to the lateral margin; surface minutely granulose, coarsely punctured, the punctures crowded on the basal groove, more scattered over the disk. Scutellum trigonate. Elytra much broader than the thorax, convex, transversely excavated below the basilar space, the latter distinctly thickened, the humeral callus also thickened; surface closely and rather coarsely punctured, bright metallic green with a bluish tint, the apex fulvous.

Much broader and more ovate than the other known species.

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

XXVI.—*On the* Nauplius *and Pupa Stage of Suctoria.* By Prof. Alfred Giard.

Gentlemen,—

In the July number of the 'Annals' Mr. C. Spence Bate published an interesting paper "On the *Nauplius* Stage of Prawns." In this he attempts to prove that the *Nauplius* described by Fritz Müller as belonging to *Penæus* cannot be the young of any prawn, but appears to be the larva of a Schizopod more or less related to *Euphausia*, or of one of the Suctorian parasites.

As far as Metschnikoff's observations enable us to decide, the *Nauplius* stage is, in fact, the earliest form of the larval condition of *Euphausia*, whilst most of the Schizopods (the *Mysis* group for example) present a condensed development. It may be also fairly assumed that this important *Nauplius* stage may be more frequent amongst the Schizopods than amongst the prawns, the latter occupying a higher rank in the class and offering a *Mysis* stage in their ontogenic evolution.

I cannot, however, admit that the opinion suggested by Mr. Spence Bate, viz. that Müller's larvæ belong to a Schizopod, is established on solid observations or on serious arguments; but I am absolutely sure this *Nauplius* cannot be related to any form of the Suctoria. Lilljeborg and Anderson have long ago suspected the presence of the male organs of Suctoria. In 1873 I myself described the testes and the spermatozoids of *Sacculina* and *Peltogaster* *. I have thus been much surprised on reading that an accurate observer and distinguished carcinologist like Spence Bate still asks, "Of what form is the male of Suctoria? and when does the female become impregnated?" I was equally astonished at the following:—"What do we know of the development of *Sacculina, Cleistosoma, Peltogaster*, or any of the parasitic Suctoria? or as to what changes these undergo after the *Nauplius* stage before they attach themselves as parasites to other Crustacea?" for in my previous papers I made known the numerous and rapid transformations undergone by the embryo of Suctoria after its hatching and before fixing itself. I even mentioned that I had been led to such researches by the difficulty, pointed out by Mr. Spence Bate, of preserving the life of these delicate creatures.

I regard as highly characteristic of the *Nauplius* of Suctoria and generally of Cirrepdia, the presence of two frontal horns into which open the deferent canals of two enormous glands. I know from verbal communication that Professor Lacaze-Duthiers did not find these horns in the embryo of *Laura*, which I look upon not as a species of Crustacea but as a real type of Suctoria. But I know from experience that in some species of *Peltogaster* they can only be found after careful examination; and I am convinced that, attention being directed to that point, they will be found in the embryo of *Laura*.

Semper and Rossman described, long before Dr. Power, some species of Suctoria in which the embryo seems to hatch with the *pupa*-form of Cirripedia. I say *seems*; for, in spite of the denials of Prof. Semper, I am not yet fully convinced, on account of the rapidity of the first changes of these embryos, that the transformation of the *Nauplius* into the *Cypris* stage is not effected inside the incubatory sac. There may, however, possibly be in those cases a condensed embryology, as I have myself shown in the most different groups, and, for example, in the Tunicata. Anyhow the embryo of Suctoria never acquires a higher form than this *Cypris* stage, which in no wise resembles the figures drawn by F. Müller; and it is from this moment that the retrogressive metamorphosis begins.

I am, Gentlemen,

Yours obediently,

Lille, August 2, 1878. ALFRED GIARD.

* Comptes Rendus de l'Académie des Sciences, t. lxxvii. 1873, p. 949; C. R. t. lxxix. 6 et 27 juillet 1874; Annals and Magazine of Natural History, ser. 4, vol. xiv. pp. 381 and 386.

XXVII.—*Studies on Fossil Sponges*.—II. *Lithistidæ*. By Karl Alfred Zittel.

[Continued from p. 135.]

Attempt at a Classification of the Lithistidæ.

As to the position of the Lithistidæ with respect to the other sponges, the opinions of zoologists are somewhat divergent.

O. Schmidt*, in his last great memoir, groups all sponges in four orders: the first contains the Hexactinellidæ with sex-radiate spicules; the second includes the sponges with anchor-shaped spicules, or with spicules of the pyramidal type; the third those with uniaxial siliceous spicules and all forms destitute of spicules; and the fourth the Calcispongiæ.

In the second order we find the family Lithistidæ, together with the Geodinidæ, the Ancorinidæ, and the fossil Vermiculatæ. That this last family (which, however, is only provisionally established) cannot be maintained, as it consists of the most discordant elements, I have already demonstrated elsewhere †. Consequently there remain for the second order only the former Corticatæ (Geodinidæ and Ancorinidæ) and the Lithistidæ.

We find the Lithistidæ in a similar position in the third edition of Claus's 'Handbuch der Zoologie.' Claus places the Calcispongiæ, as an equivalent group, opposite to all the other marine sponges (Fibrospongia). The Fibrospongia are divided into twelve families, closed by the Ancorinidæ, Geodinidæ, Lithistidæ, and Hexactinellidæ in the sequence stated. Here, therefore, we also find the Lithistidæ in the immediate neighbourhood of the Geodinidæ and Ancorinidæ on the one hand, and of the Hexactinellidæ on the other.

A different and somewhat more complicated arrangement of the sponges has been proposed by H. Carter‡. Of Carter's eight orders, Carnosa, Ceratina, Psammonemata, Rhaphidonemata, Echinonemata, Holorhaphidota, Hexactinellida, and Calcarea, the first five and a great part of the sixth correspond to Oscar Schmidt's third group. Each of the first five orders is subdivided into from two to four families, and these again into a great number of groups.

The order Holorhaphidota is the most comprehensive of all, and is formed of constituents which ought hardly to be placed

* Grundzüge einer Spongienfauna des Atl. Geb. p. 83.

† Studien über fossile Spongien, i. p. 6; see Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 260.

‡ Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. (1875) pp. 1, 126, 177.

in very close connexion. Thus, among the five groups belonging to it we find, on the one hand, the Renierida, Suberitida, and Potamospongida (*Spongilla*), with uniaxial spicules; and on the other, the Pachytragida and Pachastrellida, with tri- or quadriradiate siliceous elements. Under the Pachastrellida the family Lithistina occurs as a section of the third rank.

I confine myself to the mention of these three most recent classifications of the sponges, as I have already endeavoured to show how little warrant there is for the older opinion of Bowerbank, Gray, and Wyville Thomson, that the Lithistidæ and Hexactinellidæ should be brought close together.

In one point Oscar Schmidt, Claus, and Carter agree: they all place the Lithistidæ close to the Geodinidæ and Ancorinidæ (Pachytragidæ, Carter). But whilst Claus assigns to them the rank of a distinct order, they appear only as a family of an order in Oscar Schmidt's arrangement, and by Carter they are even degraded into a subsection (family) of the Pachastrellidæ.

The agreement of the Lithistidæ with the above-mentioned sponges consists in that the anchor-shaped surface-spicules of many Lithistid genera are deceptively like certain skeleton-spicules of the Ancorinidæ and Geodinidæ. With this, however, we have exhausted all that can be said in favour of the affinity of these latter sponges to the Lithistidæ. But if we consider that in the Lithistidæ neither typical quadriradiates (as in *Steletta*), nor octoradiates, nor siliceous stellules, or radiating siliceous spherules and siliceous disks are observed, it is clear that even in the free siliceous structures there is a considerable difference. This, however, becomes positively fundamental so soon as we take into consideration the true skeletal elements. No other order of sponges at present known possesses similar composite and multifariously branched siliceous corpuscles. Although a quadriradiate axial cross lies at the foundation of the Tetracladina, there nevertheless exists a profound difference between the quadriradiate stars of the Pachytragidæ, in which the individual arms are straight and pointed, and the Lithistid corpuscles, which are more or less ramified at the ends. Moreover, as regards the peculiar union of the latter to form a generally intimately interlocking tissue, and the stony constitution of the whole sponge-body, we may perhaps find a certain analogy with this in the Hexactinellidæ, but certainly not in the other siliceous sponges. Finally, if we take into account the complicated canal-system and the external appearance of the Lithistidæ, it is again only the Hexactinellidæ among the siliceous sponges, and an extinct group of Calcispongiæ which has still to be accurately characterized, that can be compared with them.

In conclusion, the geological distribution of the Lithistidæ and the extraordinary constancy with which they have inherited their skeletal characters from the earliest periods of the earth's history, testifies to the high antiquity of the group, and against their origin from, or even near relationship to, the Pachytragidæ, which I would regard rather as an aberrant ateral branch of the Lithistidæ, if, indeed, any genetic connexion is to be assumed between them.

All these circumstances induce me to regard the Lithistidæ as a distinct order equivalent to the Hexactinellidæ, and taking its place in the system between the Pachytragidæ, Geodinidæ, and Ancorinidæ on the one hand, and the Hexactinellidæ on the other.

A detailed classification of Lithistidæ has not hitherto been attempted, as the few living genera did not show the necessity for any further subdivision, and with regard to the fossil forms as good as nothing has been known. Carter, in his classification which has already been repeatedly mentioned, certainly gives valuable hints towards a grouping of the living Lithistidæ, and also indicates that the genus *Corallistes* of Schmidt is composed of heterogeneous elements; but a systematic arrangement, or even a clearer characterization of the individual genera, was evidently not in the intention of the distinguished English spongologist.

If we bring together the living and the far more numerous fossil forms, we soon see the undeniable necessity of a systematic arrangement of the very considerable material. As in the case of the Hexactinellidæ, so here, I take into consideration, for the characterization of the larger groups, in the first place the characters of the true skeletal corpuscles, in the second the surface-spicules, and in the third the external form. In accordance with these principles the Lithistidæ may be divided into four families (Rhizomorina, Megamorina, Anomocladina, and Tetracladina), and these again in part into several sections.

Revision and Key to the Determination of the Fossil and Living Genera of Lithistidæ.

Class SPONGIÆ.

Order LITHISTIDÆ, O. Schmidt, 1870.

Massive, stony, thick-walled, generally attached siliceous sponges of very various external form. Monozoic or polyzoic.

With central stomachal cavity or scattered oscula. Stomachal cavity sometimes replaced by vertical tubes. Sponge-body composed of more or less distinctly quadriradiate or irregularly ramified skeletal elements, furnished at the ends of the branches or throughout their whole length with nodular or root-like processes, intimately interlocked, but not soldered together; and sometimes of these and of surface-spicules of quadriaxial or uniaxial type. The surface-spicules either forked anchors with a long shaft directed inwards, or short-stemmed anchors with curved and sometimes nodular or branched flukes, or, lastly, uniaxial spicules of variable form and size. Besides these, in the sarcode, minute flesh-spicules of uniaxial type.

Family 1. **Rhizomorina.**

Skeletal corpuscles irregularly branched, beset with shorter or longer, simple or composite root-like processes or nodular excrescences, with a simple or branched central canal. Skeletal elements grouped together into confused fibres, or loosely interlocked with each other. Surface-structures frequently like those of the rest of the skeleton, but uniaxial spicules and forked anchors are also present.

A. Skeletal corpuscles moderately ramified, with a short, simple canal in the main stem; loosely interlocked with each other (see Pl. VIII. fig. 6).

a. Sponge-body thick-walled, top-shaped, nodular, or basin-shaped, with vertical radial fissures, which are frequently furcate towards the outside, and into which run fine radial canals standing serially one above the other.

Cnemidiastrum, Zitt. (Jura). Top-shaped, nodular or basin-shaped, with small round canal-ostia on the radial fissures.

Corallidium, Zitt. (Jura). Top-shaped; surface coated with epidermis up to the upper margin.

b. Sponge-body basin-shaped, top-shaped, or laminiform. Radial canal-system very fine, indistinctly developed; in the centre sometimes vertical canals.

Hyalotragos, Zitt. (Jura). Basin-shaped or top-shaped; oscula on the inner surface; vertical canals present.

Pyrgochonia, Zitt. (Jura). Basin-shaped; elevated oscula on both sides; vertical canals in the centre.

Discostroma, Zitt. (Jura). Disciform: upper surface convex, frizzled, with a central cavity; lower surface with smooth epidermis.

Epistomella, Zitt. (Jura). Laminiform; upper surface with elevated oscula; lower surface porous.

Leiodorella, Zitt. (Jura). Laminiform, cylindrical, nodular; both surfaces with margined oscula; between them smooth epidermis.

Platychonia, Zitt. (Jura). Laminiform; both surfaces with fine pores.

B. Skeletal corpuscles strongly branched, with a rather wide ramified canal, often interlocked to form fibre-like trains.

a. Sponge-body nodular or branched, without a distinct canal-system. Surface with scattered oscula, which are sometimes pit-like, sometimes radiate, or sometimes only with fine pores.

Bolidium, Zitt. (Cretaceous). Nodular or branched, without oscula.
Astrobolia, Zitt. (Cretaceous). Nodular, with scattered, radiate or large pit-like oscula.

b. Sponge-body basin-shaped, cup-shaped, ear-shaped, or laminiform. Wall with oscula or pores on one or both surfaces; from these simple or slightly ramified and generally curved canals penetrate perpendicularly into the wall, but do not traverse it. Surface-spicules, when present, like the skeletal elements, or forked anchors, sometimes also anchors with recurved prongs. Uniaxial spicules are also generally present in abundance.

Chonella, Zitt. (Cretaceous). Cup- or basin-shaped; both surfaces furnished with pores.
Seliscothon, Zitt. (Cretaceous). Basin-, cup-, or plate-shaped; wall consisting of vertical laminæ; on the radial canals of the inner surface there are small oscula.
Chenendopora, Lamx. (Cretaceous). Cup-shaped, stalked, with a branched root; inner surface with scattered impressed oscula; stem with vertical tubes; skeletal corpuscles rather large, knobby.
Arabescula, Cart. (Recent). Thin, incrusting; surface with pores and fine furrows.
Corallistes, Schm. (Recent). Cup- or basin-shaped, or curved discoid; oscula on the inner surface; surface covered with a coat of forked anchors.
Heterophymia, Pom. (Recent). Fan-shaped, undulately folded; upper surface with oscula; under surface porous. Surface-spicules of the under surface curved anchors with short incrassate prongs; of the upper surface smooth, irregularly branched corpuscles of small size.
Macandrewia, Gray (Recent). Vase-shaped or clavate. Inner surface with warty oscula. Surface-spicules consisting of a short shaft and three branched, finely divided, and curved arms. Flesh-spicules uniaxial, pointed at both ends.
Azorica, Cart. (Recent). Vase-shaped, stalked. Warty oscula on the inner surface. Skeletal corpuscles small. Main branches smooth, strongly branched at the ends. Surface-structures resembling the skeletal elements.
Leiodermatium, Schm. (Recent). Like *Azorica*, but the prominent oscula on the outside.
Verruculina, Zitt. (Cretaceous). Basin-, cup-, or ear-shaped or laminiform. Inner (upper) surface with prominent warty oscula. Surface-elements like those of the skeleton.
Amphithelion, Zitt. (Jura, Cretaceous). Like *Verruculina*, but with warty oscula on both surfaces.

c. Sponge-body massive, cylindrical; vertex convex, truncate, or depressed. In the interior vertical tubes, either scattered or grouped in bundles. Radial canals simple, radiating from the centre towards the periphery.

Stichophyma, Pom. (Cretaceous). Vertex convex, with scattered warty oscula, connected with vertical tubes.

Jereica, Zitt. (Cretaceous). Vertex truncate or depressed, with a bundle of vertical tubes in the middle.

Pomelia, Zitt. (Miocene, Recent). Clavate; vertex convex, with numerous fine vertical tubes opening into a small depression; at the sides also isolated pits furnished with tubes. Surface finely porous.

d. Sponge-body cylindrical, trochiform, or globular, thick-walled, with a simple central cavity. Oblique, capillary, perforating, and sometimes also coarser radial canals opening into the stomachal cavity.

Cœlocorypha, Zitt. (Cretaceous). Globular or trochiform. Stomachal cavity shallow; only fine radial canals.

Scytalia, Zitt. (Cretaceous). Cylindrical. Stomachal cavity reaching to the base; besides the fine radial canals there are coarser ones opening into the stomachal cavity.

Pachinion, Zitt. (Cretaceous). Cylindrical. Stomachal cavity wide, deep; skeletal elements knobby, very large; surface-corpuscles small, fine, branched.

Stachyspongia, Zitt. (Cretaceous). Cylindrical. Stomachal cavity simple, tubular; surface with conical tubercles.

Family 2. **Megamorina.**

Skeletal elements large, elongated, smooth, curved, irregularly branched, or only forked at the ends, with a simple axial canal, loosely interlocked with each other (Pl. VIII. figs. 3 & 4). Among them sometimes smaller skeletal corpuscles of Rhizomorine type. Surface-spicules uniaxial or forked anchors.

Megalithista, Zitt. (Jura). Cylindrical or basin-shaped, with simple central cavity. In the surface-layer numerous bacillar spicules and a few forked anchors.

Doryderma, Zitt. (Cretaceous). Cylindrical or branched, with a bundle of vertical tubes in the centre. Surface meshed; in the meshes there are tufts of short-toothed forked anchors with very long shafts turned inwards.

Lyidium, Schm. (Recent). Basin-shaped; on both surfaces with ostia of coarse simple canals. Skeletal elements branched, smooth, with thickened ends. Surface-spicules uniaxial.

Carterella, Zitt. (Cretaceous). Cylindrical, much elongated, with traversing vertical tubes. Skeletal elements very long, very sparsely branched.

Isorhaphinia, Zitt. (Cretaceous). Cylindrical, with a wide central cavity. Skeletal elements spiculiform, only slightly forked or thickened at the ends.

Heterostinia, Zitt. (Cretaceous). Vase-like, stalked, with branched roots. Wall on both surfaces with ostia and radial canals. Skeleton consisting partly of large branched megamorine, and partly of smaller knobby rhizomorine elements.

Family 3. **Anomocladina.**

Skeletal elements consisting of four or more smooth arms meeting in a thickened centre; arms forked at the end (Pl. VIII. fig. 5). Bacillar spicules are also present in great abundance.

Melonella, Zitt. (Jura). Globular or pyriform, with wide central cavity, into which arched canals open. Oblique radial canals running upwards and outwards from the centre are also present. Base with siliceous epidermis.

Cylindrophyma, Zitt. (Jura). Cylindrical, with wide central cavity. Radial canals horizontal.

Lecanella, Zitt. (Jura). Basin-shaped, thin-walled. Canal-system absent.

Mastosia, Zitt. (Jura). Nodular, with warty elevations; surface with fine pores.

Family 4. **Tetracladina.**

Skeletal elements quadriradiate, the four arms branched or thickened at the ends, with four axial canals meeting at angles of 120° (Pl. VIII. fig. 1). Surface-spicules generally present in abundance (forked anchors, lobate or entire siliceous disks, and bacillar spicules).

a. Sponge-body hemispherical to trochiform, not adherent. Base coated with a wrinkled siliceous membrane. Skeletal elements indistinctly quadriradiate, the smooth arms strongly branched at the ends. Stomachal cavity simple, with ostia of curved canals; besides these, radial canals obliquely directed outwards.

Aulocopium, Oswald (Silurian).

b. Sponge-body cylindrical, pyriform, globular, rarely basin-shaped, simple or branched. Skeletal elements with four equal, smooth, rarely somewhat knobby arms, ramified at the ends. Surface with forked anchors and uniaxial spicules.

Phymatella, Zitt. (Cretaceous). Cylindrical, with nodular excrescences. Central cavity wide. Radial canals horizontal.

Aulaxinia, Zitt. (Cretaceous). Elongate, pyriform, massive. Surface with longitudinal furrows, in which radial canals open. Root with distorted elongated skeletal elements (Pl. VIII. fig. 2).

Callopegma, Zitt. (Cretaceous). Basin-shaped, with wide central cavity. Surface with forked anchors.

Trachysycon, Zitt. (Cretaceous). Fig-shaped, with tubular stomachal cavity. Surface with conical warts. Radial canals horizontal.

Siphonia, Park. (Cretaceous). Fig-shaped or pyriform, stalked. Central cavity wide, with ostia of bent radial canals. There are also canals running obliquely from within outwards.

Jerea, Lamx. (Cretaceous). Like *Siphonia*, but with a bundle of vertical tubes, the ostia of which open at the vertex.

Nelumbia, Pom. (Cretaceous). Clavate. Vertex with the ostia of short vertical tubes. Sides with impressions in which canals open.

?*Marginospongia*, D'Orb. (Cretaceous). Cup-shaped, stalked. Wall traversed by vertical tubes.

Polyjerea, From. (Cretaceous). Tufted. All individuals traversed by tubular canals. Surface coated with a siliceous skin consisting of small branched lithistid corpuscles.

Astrocladia, Zitt. (Cretaceous). Simple or branched, cylindrical, massive. Oscula scattered, in connexion with tubular canals.

Calymmatina, Zitt. (Cretaceous). Branched or simple. The individuals trochiform, with simple stomachal cavity. Surface rough, completely coated with a siliceous skin in which forked anchors lie.

Thecosiphonia, Zitt. (Cretaceous). Simple or polyzoic. Individuals trochiform. Vertex with an impressed pit, in which are the openings of vertical tubes. Base and a part of the sides coated with siliceous skin.

Turonia, Mich. (Cretaceous). Irregular, nodular. Upper surface convex or conical, rough, with longitudinal furrows. In the interior scattered vertical tubes. Base with a siliceous skin, in which are forked anchors.

c. Skeletal elements quadriradiate, strongly branched at the ends. In the surface short-shafted forked anchors with curved prongs, or with lobate or round, short-stalked siliceous disks.

Theonella, Gray (Cretaceous and Recent). Cup-shaped. Outer surface porous; inner surface with numerous not prominent oscula. Anchors of the surface with curved forked prongs.

Discodermia, Bocage (Cretaceous and Recent). Cup-shaped. Surface with entire-margined rounded siliceous disks.

Kaliapsis, Bow. (Recent). Incrusting, thin, without oscula. Surface with toothed, multilobate, short-stalked, siliceous disks.

Rhacodiscula, Zitt. (Cretaceous and Recent). Clavate, nodular, cylindrical or cup-shaped. Surface with lobate, short-stalked, siliceous disks.

Rhagadinia, Zitt. (Cretaceous). Basin-shaped or laminar. Surface with furrow-canals. Covering layer consisting of lobate, short-stalked, siliceous disks and bacillar spicules.

d. Skeletal elements large, quadriradiate, knobby, with the ends either very slightly branched or merely thickened.

Plinthosella, Zitt. (Cretaceous). Globular or nodular. Surface with large, tile-like, entire-margined or lobate siliceous disks.

Spongodiscus, Zitt. (Cretaceous). Disciform. Upper surface with radiating ribs. Canal-system wanting.

In this classification, with a few exceptions, only such genera are accepted as I have myself examined microscopically. I have left out of consideration a number of the genera of

Billings, Courtiller, Pomel, &c., because the extant descriptions and figures furnish no information as to the minuter structural characters.

The Silurian genus *Aulocopium* presents some difficulties. Its skeletal elements are of indifferent type: in many respects they resemble those of the Tetracladina; but their irregularity approximates them equally to Anomocladina, and even to certain Rhizomorina. This is a significant hint as to the history of the development of the Lithistid stem. In the Silurian formation the different groups appear not to have yet acquired the differentiation which they show later on; the characters which subsequently divided themselves between the individual families are in part still united in the old collective type.

The Anomocladina also occupy a similar position. They show affinities in all directions; but it is impossible for the present to bring them into genetic connexion with any other group of Lithistidæ.

The other groups, Rhizomorina, Megamorina, and Tetracladina, may be with great certainty distinguished from one another by their microstructure, as a glance at the Tables shows. The Jurassic Rhizomorina, in their short, simple, axial canal, present a remarkable difference from the Cretaceous and recent representatives of this group. All the Jurassic genera of Rhizomorina possess very similar skeletal corpuscles; so that the nature of the skeleton alone does not suffice to characterize the genera. *Mutatis mutandis* this applies also to the Cretaceous Tetracladina and Rhizomorina.

Habitat and Distribution of the Recent Lithistidæ.

The circumstance that the first recent form belonging to the Lithistidæ (*Macandrewia azorica*, Gray) was described in 1859, proves sufficiently that these sponges are not to be reckoned among the easily accessible inhabitants of our sea-coasts. In fact nearly all the species at present known have been brought up from the ocean by the dredge; and the few data as to their bathymetrical distribution, for which we are indebted to O. Schmidt and Carter, would indicate that the Lithistidæ dwell between 75 and 374 fathoms, and frequently occur associated with Hexactinellidæ. The following Table contains the extant information as to their geographical and bathymetrical distribution *.

* The species marked with an * are those which I have had the opportunity of examining in nature.

Species.	Habitat.	Depth in fathoms.	Authority.
A. Rhizomorina.			
*Corallistes Bowerbanki, *Johnst.*, sp. (*C. typus*, O. Schm.).	Madeira, Cape St. Vincent, West Indies; Florida.	75–374 152–228	Carter. O. Schmidt.
*Corallistes Masoni, *Bow.*, sp. (*Dactylocalyx Masoni*, Bow.).	Madeira.	?	
*Corallistes microtuberculatus, *Schm.*	St. Iago, Cape Verd.	?	
*Corallistes elegantior, *Schm.*	Portugal.	?	
*—— noli-tangere, *Schm.*	Portugal, St. Iago.	?	
Heterophymia (Dactylocalyx) heteroformis (*Val.*, sp.), *Bow.*	Shanghai.	?	
*Macandrewia azorica, *Gray*	Azores; Färoe Islands; St. Vincent, W. Indies.	75-374	Carter.
*—— (Corallistes) clavatella, *Schm.*	Florida.	152–270	O. Schmidt.
*Pomelia Schmidti, *Zitt.*	Florida.	?	
*Azorica Pfeifferæ, *Cart.*	Madeira, St. Vincent.	75–374	Carter.
—— (Corallistes) borealis, *Cart.*, sp.	Färoe Islands.	?	
*Leiodermatium lynceum, *Schm.*	Portugal.	?	
—— ramosum, *Schm.*...........	Florida.	125	O. Schmidt.
*Arabescula parasitica, *Cart.*	Eng. Channel, Seychelles.	?	
B. Megamorina.			
*Lyidium torquilla, *Schm.*	Cuba.	270	O. Schmidt.
C. Tetracladina.			
*Theonella Swinhoei, *Gray*	Formosa.	?	
*—— (Dactylocalyx) Pratti, *Bow.*	East Indies.	?	
*—— ferruginea, *Häck.*	?	?	
Rhacodiscula asteroides, *Cart.* sp. (*Corallistes polydiscus*, Schm. non Bow.).	Florida.	152–270	O. Schmidt.
*Rhacodiscula, sp., nov.	Philippines.	?	Carter.
*Kaliapsis cidaris, *Bow.*	Pacific.	?	
*Discodermia polydiscus, *Boc.*, sp. (*Dactylocalyx polydiscus*, Bow.).	Portugal, St. Iago, St. Vincent.	75–374	Carter.

Phyletic Development.

From the mode of life of the existing Lithistidæ we may fairly conclude that their fossil ancestors also preferred to dwell in moderately deep water. The fossil Lithistidæ, especially in the Upper Jura, and here and there also in the Upper Cretaceous, are very frequently accompanied by numerous Hexactinellidæ; but there are localities (*e. g.* the Chalk of Touraine, Normandy, and Yorkshire) where the Lithistidæ occur in great quantities, and the Hexactinellidæ only very sparingly. This indicates that the conditions of existence of the two sponge-groups were similar but not identical. In general the living Lithistidæ appear never to occur at such great depths as the Hexactinellidæ. Deposits in which the latter predominate must therefore have been formed in deeper water than the formations which abound in Lithistidæ.

In decidedly littoral deposits we know scarcely any Lithistidæ; and this circumstance may chiefly serve to explain the evidently very imperfect materials in our palæontological museums. They are limited to isolated deposits, widely separated both in space and time, and each as a rule containing a different sponge-fauna from those of the earlier- or later-formed strata. We cannot demonstrate any constant and gradual evolution of the fossil Lithistidæ; nay, even the passage of a genus, to say nothing of a species, from one formation into a later one can hardly be proved.

The Palæozoic formations have hitherto furnished only a single well-defined genus* (*Aulocopium*).

I know of no Lithistidæ from the Trias and Lias; but I have found a *Melonella* and a species of *Cnemidiastrum* in the Hohenegger collection from the Brown Jura of the Cracow district.

The Lithistidæ are remarkably numerous, especially in individuals, in the Sponge-limestones of the White Jura. Here the genera *Cnemidiastrum*, *Hyalotragos*, *Platychonia*, and *Cylindrophyma* especially predominate. *Leiodorella*, *Epistomella*, *Pyrgochonia*, *Discostroma*, *Megalithista*, *Lecanella*, *Mastosia*, and *Melonella* occur more isolatedly. In the Lower White Jura they occur in moderate numbers along with the Hexactinellidæ which there predominate; but their chief development only appears in the White Jura δ, in which the Hexactinellidæ are rather more scanty. In the older horizons of the Cretaceous formation the Lithistidæ are not entirely deficient, but they occur only as rarities. On the other hand, the Cenomanian is the home of numerous species of *Siphonia*, *Jerea*, *Stichophyma*, *Chonella*, *Verruculina*, and *Amphithelion*. Celebrated localities are the Greensands of Blackdown and Haldon, the Glauconitic Chalk of Normandy and Touraine, and the Lower Pläner of North Germany, Saxony, Bohemia, and Bavaria.

* Possibly the insufficiently described genera *Aulocopina*, *Calathium*, and *Eospongia* of Billings also belong to the Lithistidæ. The Silurian genera *Archæocyathus* and *Trachium* of Billings require to be microscopically examined in order to ascertain whether they are really to be referred to the Hexactinellidæ.

The climax of their development is attained by the Lithistidæ in the Upper Cretaceous. In Touraine and Normandy, in Yorkshire, and in some districts of North Germany (on the Sutmerberg, near Ahlten, Linden, Boimtsdorf, Ilsenburg, Döhrnten, and Salzgitten) the multiplicity of forms of Lithistidæ is absolutely astonishing. The genera *Chonella*, *Seliscothon*, *Chenendopora*, *Verruculina*, *Amphithelion*, *Bolidium*, *Astrobolia*, *Stichophyma*, *Jereica*, *Cœlocorypha*, *Scytalia*, *Pachinion*, *Doryderma*, *Isorhaphinia*, *Phymatella*, *Callopegma*, *Trachysycon*, *Jerea*, *Polyjerea*, *Astrocladia*, *Turonia*, *Rhagadinia*, *Plinthosella*, *Spongodiscus*, &c. have here either their exclusive or their principal habitat. It is remarkable that the Cretaceous formation has not a single genus in common with the Jura.

On quitting the Cretaceous formation there are in Northern Europe only a few isolated fragments of Lithistidæ (*e.g.* in the Eocene sands of Brussels); but on the other hand, in the province of Oran, in Algeria, Pomel has discovered and described a remarkably rich Miocene Lithistid fauna. Unfortunately I have had no materials from this region at my disposal; and as Pomel's descriptions and figures relate only to the external form and the canal-system, but take little notice of the finer structural characters, I must for the present refrain from giving an opinion upon most of the genera. In general habit, however, the Lithistid fauna from the Miocene of Oran appears to be at least as nearly allied to the existing forms as to those of the Cretaceous formation. Among the numerous species of the genera *Scytophymia*, *Pleurophymia*, and *Cnemaulax* a closer examination may show representatives of *Corallistes*, *Macandrewia*, and *Azorica*; on the other hand, the genera *Jercopsis*, *Jerea*, *Allomera*, *Meta*, &c., which are exceedingly numerous in individuals, seem rather to indicate Cretaceous predecessors. To my regret I have found myself compelled to ignore most of Pomel's genera in the special part of this memoir, as a definitive arrangement of them in the system will be possible only when their structural characters have been carefully investigated.

The following Table gives a summary representation of the historical sequence of the Lithistidæ, and, at the same time, some indications of the mode in which their phyletic evolution may be conceived. For the present, with our imperfect knowledge both of the fossil and living Lithistidæ, the establishment of complete series of forms, or even the construction of a genealogical tree, is no more to be thought of than in the case of the Hexactinellidæ.

	Rhizomorina.	*Megamorina.*	*Anomocladina.*	*Tetracladina.*
RECENT.	Leiodermatium. Azorica. Macandrewia. Heterophymia. Corallistes. Arabescula. Pomelia.	Lyidium.		Discodermia. Rhacodiscula. Theonella. Kaliapsis.
MIOCENE.	Corallistes. (Scytophymia, Pleurophymia, Ægophymia). ? Cnemaulax. ? Spongoconia, ? Taseoconia. ? Tretolopia, ? Adelopia. ? Histiodia. ? Psilobolia. ? Pliobunia. ? Pleuromera. ? Allomera. ? Marisca. ? Meta. ? Ischadia. ? Streblia. ? Dichojerea. ? Jerea. Jereopsidea. ? Jereopsis.			
UPPER AND MIDDLE CRETACEOUS.	Amphithelion. Verruculina. Plococonia. Seliscothon. Chenendopora. Chonella. Stachyspongia. Pachinion. Cœlocorypha. Scytalia. Jereica. Stichophyma. Astrobolia. Bolidium.	Isorhaphinia. Heterostinia. Doryderma. Carterella.		Callopegma. Phymatella. Aulaxinia. Turonia. Calymmatina. Thecosiphonia. Astrocladia. Marginojerea. Polyjerea. Nelumbia. Jerea. Trachysycon. Siphonia. Discodermia. Rhagadinia. Plinthosella. Spongodiscus.
LOWER CRETACEOUS.	Chonella. Jereica.			
WHITE JURA (Malm).	Leiodorella. Epistomella. Platychonia. Discostroma. Pyrgochonia. Hyalotragos. Corallidium. Cnemidiastrum.	Megalithista.	Lecanella. Mastosia. Cylindrophyma. Melonella.	
DOGGER.	Cnemidiastrum.		Melonella.	
SILURIAN FORMATION.		**Aulocopium.**		

[To be continued.]

XXVIII.—*Preliminary Notices of Deep-Sea Fishes collected during the Voyage of H.M.S. 'Challenger.'* By Dr. ALBERT GÜNTHER, F.R.S., Keeper of the Zoological Department, British Museum.

[Continued from p. 187.]

BATHYLAGUS, g. n. Salmonid.

Body oblong, compressed, covered with thin deciduous scales of moderate size. No phosphorescent organs. Head short, rather compressed, with thin membranaceous bones. Mouth very narrow, transverse, anterior; the margin of the upper jaw is formed by the intermaxillary and maxillary, which is very short, dilated. Teeth in the intermaxillary rudimentary; those of the lower jaw extremely small, implanted on the edge of the bone, forming a minute serrature; a series of minute teeth across the vomer and along the palatine. Eye very large. Pectoral and ventral fins developed; the latter seven-rayed and inserted opposite to the dorsal, at considerable distance from the pectoral. Dorsal fin in the middle of the length of the body; adipose fin small, not very far from the caudal. Anal fin of moderate length or many-rayed. Gill-opening narrowed, commencing opposite to the root of the pectoral, and extending across the isthmus, the gill-membranes being united and not attached to the isthmus. Gill-rakers lanceolate, rather long; gills small; pseudobranchiæ well developed.

Bathylagus antarcticus.

D. 10. A. 22.

The length of the head is nearly two ninths of the total (without caudal); the eye one half of the length of the head.

Antarctic, 1950 fathoms.

Bathylagus atlanticus.

D. 9. A. 13.

The length of the head is two ninths of the total (without caudal); the eye one half of the length of the head.

South Atlantic, 2040 fathoms.

Alepocephalus niger.

D. 21. A. 27.

Scales small. The length of the head is one third of the total (without caudal); snout projecting beyond the mouth. Black.

North of Australia, 1400 fathoms.

PLATYTROCTES, g. n. Alepocephalid.

Body rather abbreviated, much compressed, and covered with small keeled scales. Mouth of moderate width; the maxillary and intermaxillary and mandible armed with a single series of small teeth. Palate smooth. Eye rather large. The dorsal and anal fins opposite to each other, on the tail, moderately long. Adipose fin none. Caudal forked. Pectoral small. Ventrals none. The humeral arch terminates in the middle of the chest in a long, projecting, acute spine. Gill-opening wide; six branchiostegals. Gills very narrow; pseudo-branchiæ present; gill-rakers long, lanceolate. Pyloric appendages rudimentary.

Platytroctes apus.

D. 18. A. 17.

The height of the body is more than one third of the total length (without caudal); the diameter of the eye one third of the length of the head. The maxillary does not extend to below the middle of the eye.

Mid Atlantic, 1500 fathoms.

BATHYTROCTES, g. n. Alepocephalid.

Body rather elongate, compressed, covered with scales of moderate size. Cleft of the mouth rather wide, the maxillary extending to below the middle of the large eye. Both intermaxillary and maxillary armed with a series of minute teeth, as is also the mandible. Vomer and palatine bones with similar teeth. No teeth on the tongue. Eye very large. Dorsal and anal fins moderately long, the former behind the ventrals. Adipose fin none. Caudal forked. Gills very narrow; pseudo-branchiæ present; gill-rakers long, lanceolate. Pyloric appendages in moderate number. Ova rather small.

Bathytroctes microlepis.

B. 7. D. 16. A. 17. V. 8. L. lat. ca. 70.

The maxillary extends to below the posterior third of the orbit.

South-east off Cape St. Vincent, 1090 fathoms.

Bathytroctes rostratus.

D. 20. A. 17. V. 9. L. lat. ca. 100.

The maxillary reaches to below the hind margin of the orbit; intermaxillary terminating in front in a short projection.

Off Pernambuco, 675 fathoms.

XENODERMICHTHYS, g. n. Alepocephalid.

Body rather elongate, compressed, without true scales; the skin is rather tough, finely longitudinally wrinkled, with numerous nodules, regularly arranged; minute, rudimentary, scale-like productions are imbedded in the skin, especially on the trunk. Mouth very small, with feeble jaws, and rudimentary teeth in the intermaxillary and mandible and a few in the maxillary. Palate toothless. Dorsal and anal fins equal in length. Caudal forked. Gill-opening wide, but not much extending above the level of the pectoral fin. Gills well developed, with long gill-rakers. Pseudo-branchiæ.

Xenodermichthys nodulosus.

D. 33. A. 33. P. 6. V. 5.

The height of the body is nearly one seventh of the total length (without caudal); the length of the head two elevenths. Eye of moderate size, its diameter being more than the width of the interorbital space. Uniform black.

South of Yeddo, 345 fathoms.

Halosaurus macrochir.

B. 12. D. 13. V. 10. P. 11–13. L. transv. 14/5.

Snout moderately produced, its præoral portion forming one third of its length. Eye rather small, one fourth of the post-ocular portion of the head, and one half of the width of the interorbital space. Maxillary reaching to the front margin of the eye. The length of the head is more than its distance from the root of the ventral, the origin of which is immediately before that of the dorsal. Pectoral fin with narrow base, very long, extending nearly to the root of the ventral. Scales of the lateral line larger than the others, each hidden in a pouch of black skin, with a phosphorescent organ at its base. These large scales are continued for some length on the tail, and cover the base of the anal fin, which, like the dorsal, is covered in its basal half with small scales.

Altantic, 1090 fathoms; and midway between Cape of Good Hope and Kerguelen's Land, 1375 fathoms.

Halosaurus rostratus.

B. 9. D. 10. V. 9–10. L. transv. 13/6.

The length of the head exceeds much the height of the body. The snout very much produced, spatulate, its præoral portion being more than one half its length. Eye of moderate size, its length being one third of the postocular portion of the head, and considerably less, than the width of the interorbital space. Maxillary scarcely reaching the front margin of the eye. The length of the head equals its distance from the root of the ventral, which is nearly entirely situated before the dorsal. Nearly all the scales are lost: but some of the lateral line remain; they are much larger than the other scales; and on the tail, where the lateral line approaches the lower profile, these larger scales fill up all the space between the lateral line and the anal fin.

Mid Atlantic, 2750 fathoms.

Nemichthys infans.

Body much less elongate and eye much smaller than in *N. scolopacea.* Vent twice as distant from the root of the pectorals as is the latter from the eye.

Mid Atlantic, 2500 fathoms.

CYEMA, g. n. Murænid.

This genus is the type of a new group of Murænidæ allied to the *Nemichthyina.* It combines the form of the snout of a *Nemichthys* with the soft short body of a *Leptocephalus*; but the gill-openings are very narrow and close together on the abdominal surface. Vent in about the middle of the length of the body; vertical fin well developed, confined to and surrounding the tail. Pectoral fins well developed. Eye very small.

Cyema atrum.

The cleft of the mouth extends backwards to the end of the head. Black.

Pacific and Antarctic, 1500 and 1800 fathoms.

XXIX.—*On the Mode of Development of the Tentacles in the Genus* Hydra. By M. C. MERESCHKOWSKY.

[Plate XII.]

IN my article on the new Hydroid *Monobrachium parasitum**

* Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 220.

I expressed the opinion that the fundamental number in the Hydroids (that is to say, the number which enters into the composition of all the other numbers) was not 4, but 2. I arrived at this opinion not only because numbers such as 6, 10, 14, 22, &c., which are not formed by the number 4, are to be met with often enough among the Hydroida, but also because many facts which I had come across in literature or observed myself have shown me that the appearance and sometimes the disappearance of organs in the Hydroida takes place in such a manner that they appear or disappear simultaneously two at a time.

Thus in the Medusæ belonging to *Monobrachium parasitum* I observed in a very young stage only four germinative sacs, which afterwards increased to eight sacs. The division of the four sacs into eight takes place by the simultaneous division, first, of only two sacs opposite one another, subsequently the other two sacs alone also beginning to divide longitudinally*.

In the following note it is my intention to give a description of my observations on the mode of production of the tentacles in *Hydra vulgaris* and *H. oligactis*. These observations were made in the spring of 1877 and 1878, and will serve to confirm my opinion as to the fundamental number in the Hydroida, and to establish a general law which governs the formation and the order of appearance of every organ in this class.

In the ponds of the neighbourhood of St. Petersburg *Hydra vulgaris* is met with very frequently during the whole of the summer season, and more rarely *Hydra oligactis*—distinguished from the former by the form of the body, which is distinctly divided into a cylindrical body and a peduncle of much greater tenuity.

In the month of May of the year 1877 I observed an example of the former species more than a centimetre in length in its normal uncontracted state, and furnished with seven long tentacles. Nearly in the middle of the body, but a little towards the base, this individual bore a whole colony of small *Hydræ*, buds in different stages of development, from individuals almost completely developed to others which were only in the form of short protuberances or monticules. I have represented the individual in question in Pl. XII. fig. 1. There will be seen first a small protuberance (I.) of a cylindrical and slightly conical form, entirely destitute of all traces of tentacles. The next stage here seen is represented by the bud (II.), which is a little larger and shows slight traces of tentacles, but still only as two slight elevations (*a* and *b*) of the superior

* *Loc. cit.* p. 223, pl. vi. figs. 12–14.

margin of the bud; and what is especially remarkable is that these two elevations or protuberances are placed opposite one another. I have frequently observed the first appearance of the tentacles in specimens quite recently fished out of the ponds, as also in artificial cultures in watch-glasses, following the process in one and the same individual; and the business has always been effected in the same manner. Observations made in June 1878 upon a specimen of *Hydra oligactis* found in the same locality as the preceding species proved the same thing. I may therefore say with certainty:—1, that at the commencement only two tentacles appear at once; and, 2, that these two tentacles are placed opposite each other *.

The next stage is that represented in Pl. XII. fig. 1, III. It will be observed that the first two tentacles (*a* and *b*) have become considerably elongated, and are equal in length to the body of the nursing-individual. Moreover there will be observed between the two tentacles and on one side only a very small protuberance (*c*), which represents the first indication of a third tentacle. In other specimens I have observed intermediate stages, in which the first two tentacles (*a* and *b*) had already attained a considerable length, while the third (*c*) had not yet appeared even in the form of a tubercle (Pl. XII. fig. 2). This curious creature then reminds us most strikingly of a form described by Dr. T. Strethill Wright† under the name of *Atractylis bitentaculata*, which he believed to be a mature organism. After what I have observed in *Hydra* I have no longer any doubt that we have in this Hydroid a similar case to that which is represented in fig. 2; that is to say, that *Atractylis bitentaculata* is not an independent form, but only a young stage of development of some other Hydroid. This is likewise the case with *Atractylis quadritentaculata* of the same author‡, which is also an embryonic form, although more advanced than the former.

The stage following that with three tentacles (III.) is the one represented in Pl. XII. fig. 3. This shows a young indivi-

* The first appearance of a tentacle does not differ in any way, except in size, from a very young bud still destitute of tentacles. Again, the first indications of a medusa are equally undistinguishable from a very young individual or from a very young tentacle. This is why I have already (Ann. & Mag. Nat. Hist., March 1878, pp. 250, 251) expressed the opinion that a tentacle is just as much an individual as the body of the hydranth or the manubrium of a medusa, but that, in consequence of the division of labour, the tentacle individual has been specially appropriated to the procurement of food and to defence, whilst the body itself is specially devoted to digestion. In short the hydranth is a colony.

† Journ. Anat. & Phys. i. p. 334, pl. xiv. fig. 5; and also Hincks, Brit. Hydr. p. 98.

‡ *Loc. cit.* fig. 6.

dual of *Hydra vulgaris* with four tentacles. It will be seen that the tentacle *c* is a little longer than the tentacle *d*, which is explained by the fact that *c* appeared earlier than *d*, and consequently has had a longer time to grow. This difference can only be easily observed at first; later on, when the four tentacles have grown (fig. 1, IV.), one can scarcely distinguish the tentacle *c* from *d*. But even much later one can still easily distinguish the first pair of tentacles from the second pair, which are shorter. It is true that generally each tentacle contracts independently of the other, so that it may happen that the tentacle *a* is more strongly contracted than *c*, and thus may even be the shorter of the two; but in this case it is easy to recognize the nature of the tentacle by its greater thickness. The individual IV. of fig. 1 had two long tentacles (*a* and *b*), which measured in the uncontracted state 1·25 millim.; the other two were scarcely more than half this length, one being 0·65 and the other 0·68 millim. long.

I have observed the mode of appearance of the tentacles many times in the two species; and I have no longer any doubt, 1, that they do not appear together, but one immediately after the other, and, 2, that they are arranged opposite each other and in the middle of the spaces between the first pair*. All these conclusions are not merely the results of the observation of different forms which I have had before me, but I have been able to follow them uninterruptedly upon the same individual.

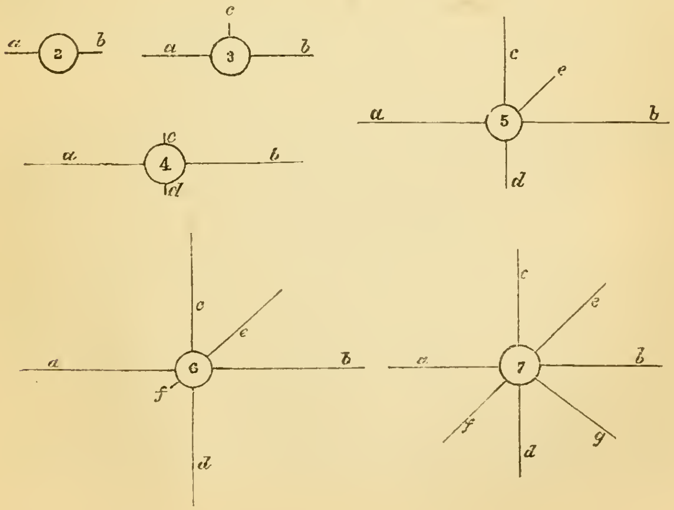
The fifth tentacle (Pl. XII. fig. 4, *e*) appears, like the third, in the form of a tubercle placed between two other tentacles, and not followed by the sixth—which does not make its appearance for some time, and, like all the others, appears on the side opposite and exactly facing the fifth. But what is especially remarkable is, that the appearance of the sixth tentacle is delayed much longer than that of the fourth (*d*) after the third. We have seen, in fact, that the fourth tentacle (*d*) appeared when the third (*c*) was still only a short cylindrical protuberance. The fifth tentacle (*e*), on the contrary, has time to become tolerably long and filiform before the sixth (*f*) makes its appearance. From all this it follows:—1, that the appearance of the sixth tentacle is much longer delayed than that of the fourth; and, 2, that the third pair is composed of two opposite tentacles, like the first two pairs.

This curious mode of appearance of the tentacles in the genus *Hydra* is, so far as I know, peculiar to it, and does not occur elsewhere among the Hydroida, in which we observe

* The two pairs being arranged so as to form a cross.

three types of development, viz. :—1, appearance in pairs; 2, appearance by four at a time; and, 3, appearance of all the tentacles at once, as, for example, in *Tubularia*. This exceptional case would serve very well to explain the fact (which is also exceptional) that in *Hydra* we very often observe the number 7, which does not accord with the formula $2 \times n$, that in general characterizes all the Cœlenterata. In fact, if the sixth tentacle does not appear until long after the fifth, we may expect that in the following (fourth) pair of tentacles the seventh will appear earlier than the eighth, and that this last will be delayed much more than even the sixth. It is in this way that we find a variable number of tentacles in the different species of *Hydra*, sometimes six, sometimes seven, sometimes eight, or even more. It may well be supposed that the individual sometimes dies before having had time to acquire an eighth tentacle, and that then, having only seven, its formula would be $(2 \times n) - 1$ or $(2 \times 4) - 1$; but from what we have seen I do not see why we should think that the number of tentacles in *Hydra* is subject to such variations that it cannot be governed by any law. On the contrary, we see that chance has nothing to do with it, that a very vigorous and constant law governs the appearance of the tentacles, and that the mode of appearance belongs to the first type that we have just established (appearance by pairs), although here it may be more or less modified.

From the diagrams below we may easily see the mode of appearance of the tentacles.



Thus the appearance of the tentacles in *Hydra* occurs in the following order:—The first two tentacles appear at the same time and are arranged opposite to each other; the other tentacles also appear in pairs, and are also arranged opposite one another: but the second tentacle of each pair always appears later than the first; and this retardation is greater in the third pair than in the second, and still greater in the fourth pair.

Taking into consideration all that has been said, I hope it will be seen that the genus *Hydra*, and especially *Hydra oligactis*, is derived from the type which is represented by the formula 2×4, as I have indicated it in the genealogical table given in my article on *Monobrachium* *.

A bud does not require a very long time for its development. The first tubercle of the individual increases in size very considerably in half an hour, and already develops two little tentacles. In about 20 hours this bud had four well-developed tentacles; and in 20 hours more there were already five tentacles.

In all this we may easily see that the facts are subjected to a general law, although, owing to the great complexity of the facts, the law does not strike one at once, and can only be ascertained by carefully studying the genesis of the animals. As a general conclusion we may admit that in *Hydra each pair of opposite tentacles forms a system*, and that these two tentacles are singularly connected in such a manner that the appearance of one tentacle is followed by that of another opposite to it. In this we observe a sort of polarity between the two metameres—a fact the frequent occurrence of which among the Hydroids I hope to prove some other time.

EXPLANATION OF PLATE XII.

Fig. 1. *Hydra vulgaris.* An adult individual with seven tentacles in a fully extended state; a little below the middle of the body it bears four buds or young individuals, namely:—I., a bud without tentacles; II., a larger bud, furnished with two tentacles (*a* and *b*) in the form of tubercles, which have appeared simultaneously and are arranged opposite one another; III., a still more advanced bud, the tentacles *a* and *b* being considerably enlarged, and the third tentacle (*c*) only presenting the form of a tubercle, without yet having the fourth tentacle opposite to it; IV., a young individual with four tentacles, two longer (*a* and *b*) and two others shorter, also arranged opposite each other (*c* and *d*), the four tentacles arranged so as to form a cross. The tentacle *c*, which appeared earlier (see III.), is a little longer than *d*.

Fig. 2. A young individual of the same species, representing the same stage as fig. 1, II., but in a more advanced state. First pair of

* Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 227.

tentacles (*a* and *b*) greatly developed, but not the smallest trace of a third tentacle, thus resembling *Atractylis bitentaculata*, Wright.

Fig. 3. A young individual of the same species in an earlier stage than that represented in fig. 1, IV. The fourth tentacle (*d*) has just appeared, while the third, opposite to it, is already tolerably long: *a* and *b* are the first pair of tentacles.

Fig. 4. *Hydra oligactis.* A young individual still attached to the parent and already furnished with five tentacles: *a* and *b* first pair; *c* and *d* second pair; *e*, fifth tentacle, the first of the third pair; the sixth is on the point of making its appearance.

XXX.—*Descriptions of new Species of Rhopalocera from Central and South America.* By F. DU CANE GODMAN and OSBERT SALVIN.

Nymphalidæ.

DANAINÆ.

1. *Callithomia panamensis.*

♂. Exp. 2·7 in. Above—basal third of primaries and basal half of secondaries rufous; marginal half of secondaries and apical third of primaries brownish black; an irregular band, crossing the primaries from the costa to the anal angle, and four spots near the apex yellow; a black spot in the middle of the cell, and another at the end confluent with the dark apex. Beneath with six submarginal white spots on the secondaries and two at apex of the primaries. Distal half of the antennæ yellow.

Hab. Panama, Candelaria (*Ribbe*).

Mus. Dr. O. Staudinger.

Obs. In coloration this species almost exactly resembles *Ceratinia megalopolis*, Feld.; the neuration, however, is that of *Callithomia*. It also much resembles *Ithomia beronilla*, Hew., a species which possibly also belongs to the genus *Callithomia*.

2. *Napeogenes pædaretus.*

♂. Exp. 2·65 in. Yellowish diaphanous; margins of both wings, and a triangular spot at the end of the cell, and the radial and median branches of the primaries black; median nervure of the primaries and space below it, the inner edge of the dark margin, also the median nervure of the secondaries and its branches fulvous; apex of the primaries clouded, except elongated yellowish diaphanous submarginal spots between the nervules. Beneath as above, with a row of seven white spots in the dark margin of the primaries, and the same number in the margin of the secondaries. Antennæ yellow, the base black.

♀. Exp. 2·9 in. Similar to the male, except that the base of the primaries is dark within the cell, leaving a yellowish spot near the end; the inner area of the secondaries is fulvous, with two indistinct yellowish spots on either side of the lower radial.

Hab. Costa Rica (*H. Rogers*).

Mus. nostr.

Obs. This is one of the largest members of the genus, and has a general resemblance in colour to *Ithomia xenos* (Bates); the female closely resembles *I. relata*, Butl., a common species in Costa Rica, and sent in some numbers in the same collection with the *Napeogenes* now described.

3. *Ithomia cæsion.*

♂. Exp. 2·1 in. Neuration as in *I. illinissa*; costa, apical half and inner margin of primaries, and margin of secondaries black; inner portion of both wings rufous; five white spots in the dark apex of the primaries, four submarginal and one (the largest) a little beyond the end of the cell. Beneath as above, with the addition of a marginal row of spots on each wing. Antennæ long, black.

Hab. Panama, Candelaria (*Ribbe*).

Mus. Dr. O. Staudinger.

Obs. This species belongs to the *I. illinissa* group, and is most nearly allied to *I. abida*, Hew. It differs in not having a black band across the secondaries.

4. *Ithomia jucunda.*

♀. Exp. 1·85 in. Diaphanous; costa, apex, outer and inner margins of primaries, and a band through the cell following the second median branch, outer margin of secondaries, and all the nervures black; a small opaque white spot beyond the dark band at the end of the cell of the primaries; within the dark margin of the secondaries, between the first and second median branches, is a rufous patch. Beneath—the centre of the dark patch at the end of the cell of the primaries, the costa, and the greater part of the margin of the secondaries rufous; base of the costa of the secondaries yellow. In neuration this species most resembles *I. terra*; the discoidal nervures of the secondaries are almost in a straight line, and carry no recurrent nervule; the junction of the lower radial with the discoidals falls in the diaphanous part of the wing.

Hab. Panama, Candelaria (*Ribbe*).

Mus. Dr. O. Staudinger.

5. *Ithomia cadra.*

♂. Exp. 2·2 in. Neuration as in *I. nephele*, which it also resembles in distribution of the dark and diaphanous parts of the wing; it differs, however, in having the median nervure and inner half of the inner margin of the primaries, and all the nervures of the secondaries, except just where they join the outer margin, rufous: the diaphanous part of the secondaries is also tinged with rufous.

Hab. Panama, Rio Gatun (*Ribbe*).

Mus. nostr. et Dr. O. Staudinger.

Obs. Two specimens obtained by Hr. Ribbe agree in the above characters, which seem to be sufficient to distinguish the species from *I. nephele*, to which it is undoubtedly closely allied, and which is also found in some numbers in Central America, as far north as Costa Rica.

6. *Ithomia rhene.*

♂. Exp. 2·15 in. Allied to *I. cassotis* as to the distribution of the dark and diaphanous portions of the wings, and belonging to the same group; the lower radial of the secondaries makes a more acute angle with the median nervure; and the cell is much longer, leaving the lower radial extremely short.

Hab. Panama (*Ribbe*).

Mus. Dr. O. Staudinger.

7. *Tithorea pinthias.*

♂, exp. 3·6 in.; ♀, 3·8 in. Allied to *T. duenna*; but the base of the primaries is black, and there is no black cross band to the secondaries; the prothorax is black, whereas in *T. duenna* it is rufous: also allied to *T. tarracina*, but differing in the absence of the yellow spots near the apex of the secondaries.

Hab. Panama (*M'Leannan*); Veragua (*Arcé*); Costa Rica (*Rogers*); Nicaragua, Chontales (*Belt*).

Mus. nostr.

We have long hesitated to differentiate this species; but so many examples have now come under our observation, all agreeing accurately with one another, that we think there can be no doubt that the race is a well-defined one, distinct both from its northern relative, *T. duenna*, and from its southern, *T. tarracina*.

Brassolinæ.

8. *Narope testacea.*

♂. Exp. 2·3 in. Above nearly uniform dull brick-red;

apex of the primaries and inner half of the secondaries dull brown. Beneath pale earthy brown, mottled all over with dark scales and spots indistinctly arranged in bands across the cell of the primaries, and more or less parallel to the outer margin; a small black spot near the middle of the costa of the secondaries.

♀. Exp. 2·5 in. Outer margin of primaries convex; outer margin of secondaries slightly angulated. Above uniform earthy brown: beneath paler and sparsely sprinkled with small black spots; a faint pale line runs from the apex of the primaries towards the middle of the inner margin.

Hab. Chiriqui (*Ribbe*).

Mus. Dr. O. Staudinger.

Nymphalinæ.

9. *Phyciodes chromis.*

♀. Exp. 1·9 in. Outer margin of primaries deeply indented. Above brown; a large angulated spot beyond the cell of the primaries, a narrow oblique one within the cell, and five others placed irregularly between the large spot and the outer margin dull yellow; secondaries with a reddish-brown transverse band beyond the cell, a submarginal row of lunules, and between them a third indistinct reddish-brown band. Spots of primaries beneath as above, the base of the wing being pale reddish with dark marks; secondaries reddish brown, with irregular indistinct dark marks, the largest being on the middle of the costa, on either side of which is a lighter transverse line.

Hab. Chiriqui (*Ribbe*).

Mus. Dr. O. Staudinger.

10. *Phyciodes diallus.*

♀. Exp. 1·9 in. Outer margin of the primaries deeply indented. Above brown; a small oblique spot within the cell of the primaries, a large one beyond it cut by the nervules, another below it cut by the median branches, two small spots near the middle of the outer margin, and two others in the apex near the costa white; secondaries with three bands of dark ferruginous brown, nearly concentric with the outer margin. Beneath reddish brown, variegated with lighter shades of the same colour; white spots of the primaries the same as on the upper surface: the secondaries have a large reddish-brown spot about the middle of the costa, and the outer margin of the same colour from the middle to the anal angle; there is also an indistinct light spot in the middle of the wing beyond the cell.

Hab. Chiriqui (*Ribbe*).

Mus. Dr. O. Staudinger.

11. *Phyciodes poltis.*

♂. Exp. 1·5 in. Outer margin of primaries very slightly concave. Above dark brown; an oblique spot beyond the cell, a round one over the middle of the median branches, a small one near it between the submedian and first median branch fulvous: secondaries with an extracellular transverse pale fulvous band, the part nearest the apical angle reddish fulvous. Beneath—primaries tawny; a dark band, enclosing spots corresponding with those of the upperside, crosses the wing from the costa to the anal angle; outer margin variegated with tawny and reddish brown, some whitish spots on the costal margin near the apex: secondaries yellowish white at the base; an indistinct darkish band crosses the wing from the costa to the inner margin, outside of which is a pale band which embraces the apical angle and crosses the wing to inside the apical angle, which, with the greater part of the outer margin, is reddish and contains a row of black spots.

Hab. Mexico (*Boucard*).

Mus. H. Druce.

The nearest ally of this species seems to be *P. orthia* (Hew.), of South Brazil.

12. *Phyciodes fulgora.*

♂. Exp. 1·7 in. Outer margin of primaries with a deep indentation. Upperside dark brown; a large fulvous patch, consisting of two nearly confluent spots, crosses the wing beyond the cell from the costa to the inner margin; a small spot at the end of the cell, two small white spots near the apex: secondaries with a broad median tawny band and two faint lines of lunules parallel to the outer margin. Beneath reddish tawny, the spots of the upper surface indistinctly shown; some dark lines across the cell, and dark spots near the outer margin between the radial nervures: secondaries pale tawny, inner portion mottled with darker marks; outer part (except the apical angle) dark, enclosing a row of four black subtriangular spots; a line of pale lunules parallel to the outer margin.

♀. Similar to the ♂, but rather larger; the fulvous spots on the primaries larger and confluent.

Hab. Costa Rica (*H. Rogers*).

Mus. nostr.

13. *Phyciodes sopolis.*

♂. Exp. 1·5 in. Outer margin of primaries but slightly concave. Above brown; an indistinct tawny spot in the cell, and a similar one below it; an oblique yellowish spot cut by the nervures beyond the cell touching the costa, and two small yellow spots, one near the middle of the outer margin, the other near the apical angle: secondaries uniform brown, with an obsolete submarginal line of lunules. Primaries beneath rich brown, with transverse oblique bands of tawny running from the costa: secondaries pinkish brown, distinctly variegated with dark patches and dark brown lines running very irregularly across the wing; there are dark patches on the costa and the outer margin, including the anal angle, and an indistinct series of ocelli parallel to the outer margin.

Hab. Choctum, Vera Paz (*G. & S.*).

Mus. nostr.

This species, of which we possess two specimens, seems most nearly allied to *P. fulviplaga*, Butl., but has a much smaller yellow spot on the primaries, and the same wings beneath are variegated at the base instead of being rich uniform brownish black.

14. *Phyciodes sosis.*

♂. Exp. 1·5 in. Allied to *P. ardys* (Hew.), from which it mainly differs in wanting the median yellowish transverse band on the secondaries, having in place of it a very narrow broken line of lunules parallel to the outer margin. Beneath the markings are much as in *P. ardys*, but more distinct, especially on the secondaries.

Hab. Costa Rica (*H. Rogers*).

Mus. nostr. Many examples.

This species has also some resemblance to that recently described by us as *P. drymæa* from Guatemala; but the spots on the primaries are larger than in that species, and the central band on the secondaries is formed of lunules instead of isolated spots. The markings of the underside are also more definite.

15. *Phyciodes cassiopea.*

♀. Exp. 1·9 in. Outer margin with deep indentation. Above dark brown; seven whitish spots on the apical two thirds of the primaries: secondaries crossed by a median transverse band; a submarginal row of lunules, and inside this row an indistinct line parallel to the outer margin. Base of the primaries beneath reddish: secondaries pale pinkish brown, outer margin dark, and a dark mark on the costa near the apical angle; a submarginal row of lunules and dark irregular marks across the rest of the wing.

Hab. Costa Rica (*H. Rogers*).

Mus. nostr.

This species has a reddish base to the primaries beneath as in *P. smerdis* (Hew.); but the pattern of the secondaries beneath is different. We have not yet received the male.

16. *Phyciodes Durnfordi.*

♂. Exp. 1·4 in. Above uniform dark brown, with obsolete red spots in and about the cell of the primaries, and one at the end of the cell of the secondaries. Beneath—primaries reddish brown; between the end of the cell and outer margin is a broad dark band containing two light spots, one on the costa, the other on the inner margin; a narrower dark band crosses the wing through the end of the cell; two others still narrower cross the cell itself: secondaries brown, marked with barely perceptible lighter and darker marks; there is a submarginal row of very indistinct lunules, inside of which are four white spots.

♀. Exp. 1·55 in. Above dark brown, with the red markings of the male larger and much more distinct. Beneath much paler, the markings on both wings are also more plainly shown.

Hab. Buenos Ayres (*H. Durnford*).

Mus. nostr.

17. *Phyciodes taphius.*

♂. Exp. 1·5 in. Above brown; apex of the primaries darker; a band of three separate fulvous spots crosses the wing from the costa to the anal angle: the secondaries have three concentric lines of pale tawny. Beneath dull yellow; a tawny streak crosses the primaries; from the costa to the anal angle whitish; spots at the apex near the middle of the outer margin; both wings have a submarginal row of light lunules: the basal half of the secondaries mottled with light markings; three black spots with light edgings between the median branches.

Hab. Ecuador, Canelos and St. Inez (*Buckley*).

Mus. nostr.

Obs. The nearest ally is *P. elaphiœa* (Hew.), from which it differs in having the band of the primaries broken.

18. *Eresia epione.*

♂. Exp. 2 in. Above uniform dark steel-blue; inner margin of secondaries red. Beneath brown; nervures and line between each black; base of the secondaries yellow.

Hab. Antioquia (*Salmon*).

Mus. nostr.

19. *Eubagis geta.*

♂. Exp. 1·8 in. Above sage-green; apex and outer margin of primaries black, deeply indented on the inner side. Beneath blackish brown, with six large white spots, one at the apex and one close to the middle of the outer margin, one beyond the cell touching the costa, one over the middle of the first median branch, one crossing the median nervure into the cell, and one at the base of the cell; outer margin rufous towards the apex; secondaries white, crossed by five dark narrow rufous bands.

Hab. Apolobamba, Bolivia.

Mus. nostr.

Obs. Allied to *E. ines*, Godt., from Brazil, the dark apex of which encloses a green spot—this spot in the present species being confluent with the green of the rest of the wing. *E. ines* has a narrow submarginal black line on the underside of the primaries, not seen in *E. geta.*

E. setabis of Doubl. & Hew., from Venezuela and New Granada, which has been united to *E. ines*, seems to us to be a distinct species.

20. *Callithea Bartletti.*

♂. Exp. 2·5 in. Above deep purple, central area of the primaries almost black; apex (broadly) and outer margin of both primaries and secondaries metallic green. Beneath—basal third of primaries and basal half of secondaries ochre; rest of both wings green; end of the cell and on either side of the first median branch of primaries blackish; a black spot between the first and second median branches and three others running parallel to the outer margin; the secondaries have four bands of spots on the distal half arranged parallel to the outer margin.

♀. Exp. 2·5 in. Apex of primaries more rounded than in the male; base of the wings greenish black instead of purple, the green margin of both wings broader.

Hab. Lower Ucayali (*E. Bartlett*); Rio Napo.

Mus. nostr.

Obs. Allied to *C. Degandi*, the chief difference consisting in the deep purple colour of the upper surface, which in *C. Degandi* is rich blue. On the under surface they are nearly alike.

We have long had specimens of this species from Mr. Bartlett's collection in our possession; the receipt of additional examples, including the female, from the Rio Napo, sent to Mr. Whitely by a correspondent, induces us to describe it.

21. *Adelpha sophax.*

♂. Exp. 2·1 inch. Above dark brown; primaries with obsolete darker bands across the cell; the secondaries have three lighter bands parallel to the margin, and a fourth straight, passing across the wing through the cell to the anal angle; a fulvous band crosses the primaries from the anal angle to the costa beyond the cell. Beneath fulvous: the primaries with a band corresponding to that on the upper surface silvery white; four spots in the apex and two in the cell, the basal one triangular, the outer one oval; both the latter margined with black: secondaries have a dark, nearly straight band crossing the wing beyond the cell to the anal angle; the margins of this line are lighter; an irregular band of silvery white crosses the cell near its base, another crosses the wing through the end of the cell; there is also a submarginal row of seven spots of the same colour.

Hab. Costa Rica (*H. Rogers*); New Granada.

Mus. nostr.

Obs. In the coloration of the upper surface this species resembles *A. tizona* (Feld.). On the underside it resembles *A. epione*, Godt., from which it differs chiefly in having a submarginal row of white spots on the hind wings and in the coloration of the bands.

Papilionidæ.

Pierinæ.

22. *Leptalis Ribbei.*

♀. Exp. 1·95 in. Above dark brown; nearly the whole of the cell, and the area below the median nervure from the origin of the third branch nearly to the subcostal nervure, and the posterior wings except the margin diaphanous; the nervures dark; an apical spot and a band divided in two, running from the costa to the anal angle of the primaries, white. Beneath—the dark markings paler; a submarginal band inside a row of six white spots on the secondaries, a submarginal row of obsolete white spots on the primaries.

Hab. Chiriqui (*Ribbe*).

Mus. Dr. O. Staudinger.

Obs. Allied to *L. theonoë*; but the diaphanous portion of the basal half of the primaries is much more extensive, the apical spot on the primaries is very small, and there is no spot on the costa near the apical angle of the secondaries.

Dr. Staudinger's collection contains a single specimen of this species, the only one we have yet seen.

XXXI.—*On the Identity of the Ophiuran Genera* Ophiopleura, *Danielssen and Koren*, and Lütkenia, *Duncan, with Notes on the Species*. By Prof. P. Martin Duncan, M.B. Lond., F.R.S., &c.

The remarkable Ophiurans collected at Discovery Bay by Mr. Hart, naturalist on board H.M.S. 'Discovery,' were described by me in the 'Annals' for August 1878; and their structural characteristics were so remarkable and different from those of any genus with which I was acquainted, that it was necessary to include the forms under a species of a new genus, *Lütkenia.*

Of course all the available literature, relating to the northern Ophiurans especially, was searched before the generic diagnosis and title were decided upon; and I was not aware that any thing had been published relating to the subject later than Marenzeller's report on the Cœlenterata, Echinodermata, and worms of the Austro-Hungarian North-pole expedition, 1877. But a "Separat-Aftryk af Nyt Magazin for Naturvidenskaberne," Christiania, was published in 1877; and it relates to the Echinodermata of the Norske Nordhavsexpedition, written by Danielssen and Koren.

It contains the description of an Ophiuran which was sufficiently peculiar to be separated from all others in a new genus, *Ophiopleura*. The single species is fortunately well illustrated and has been called *Ophiopleura borealis*, Dan. & K. The specimens came from 510–570 fathoms, temperature 1°·3 C., and not further north than 63° 5′ N. lat.

The form was so decidedly separable, that the Scandinavians made a new family for its reception; and they consider the irregular arrangement and shape of the teeth of paramount importance:—"Tænderne i uregelmæssige Rækker, fladtrykte, tilspidsede." This is the essential characteristic of *Lütkenia*, nobis. Again, their generic diagnosis corresponds with that of the genus I had established, with an exception which is somewhat remarkable. In the description of the species much is made of the presence of ten "Ribber" on the upper surface of the disk, some 15 millims. long and 12 millims. broad, with spaces between them and a clear centrum. These very prominent objects on a disk with a circular outline are exceedingly striking. They are associated with very small wide-apart radial shields. The mouth-papillæ are numerous, and three are beneath the irregular set of rows of true teeth; and the tentacle-papillæ are numerous. The "Ribber" are not in the specimens of *Lütkenia arctica*, nobis; but the other details are visible, with slight and specific differences. What, then, are these ten "Ribber"? I find that in *Lütkenia* the body is rather more pentagonal than circular in outline; but there is a swollen condition of the upper part of the disk in situations corresponding with the sacs leading downwards into the remarkably limited generative openings; this is all; and the radial shields correspond with those of *Ophiopleura*. There can be little doubt that the "Ribber" are of secondary importance; and therefore I give the distinguished Scandinavian naturalists their due, and withdraw *Lütkenia*.

The question now arises, is the species *Ophiopleura borealis* of those authors identical with *Lütkenia arctica*? or are the structural differences sufficient to separate them specifically? The following are the distinctions; and I have taken the opportunity of again studying the species I named, so as to be doubly sure. The species from Smith's Sound has no "Ribber;" its disk-scaling is smaller than in the species *borealis*; and the outline is pentagonal instead of circular. The upper arm-plates are more convex and more medianly pointed in the arctic species; and the second and third lower arm-plates of the boreal form differ entirely. The other lower arm-plates have the breadth, but the few within the disk have not the aboral point of the arctic form. The jaws differ in shape: the accessory pieces are not seen in *Ophiopleura borealis*; and its tentacle-scales are differently arranged and are more numerous in mid arm than in the other form. The arctic forms have round tentacle-spaces, and the others have them elongate, at the root of the arms. The mass of tentacle-scales and accessory pieces at their base, in relation to the tentacle at the side of the first lower arm-plate, are very strongly marked in the form from Smith's Sound, but not so in that described from the sea to the east of Greenland. Both are very fine forms and large; and the slight increase of dimensions in the boreal type is not sufficient to explain the structural differences. I therefore consider the species *arctica* to hold good and the classificatory position to be as follows:—

Family **Ophiopleuridæ.**

Genus Ophiopleura, Dan. & K. 1877.

1. *Ophiopleura borealis*, Dan. & K.

2. *Ophiopleura arctica*, Duncan.

I have to express my thanks to the Rev. A. M. Norman, F.L.S., for sending me the "Separat-Aftryk" and for drawing my attention to the identity of *Ophiopleura* and *Lütkenia*.

August 9, 1878.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

March 20th, 1878.—Henry Clifton Sorby, Esq., F.R.S., President, in the Chair.

The following communications were read:—

1. "Note on an Os articulare, presumably that of *Iguanodon Mantelli*." By J. W. Hulke, Esq., F.R.S., F.G.S.

In this paper the author described what he believed to be the os articulare of *Iguanodon Mantelli*, from the best specimen of a series of five collected by the Rev. W. Fox, of Brixton, in the Isle of Wight. He remarked that the mandible represented by this bone differs greatly from that of the Crocodilia, and in a less degree from that of extant Lizards, while in some respects it resembles that of *Hypsilophodon Foxii*. From this resemblance and the relative abundance of the bone in the same beds which have yielded mandibular rami of *Iguanodon*, he felt justified in referring the bone to the latter Saurian.

2. "Description of a new Fish from the Lower Chalk of Dover." By E. Tulley Newton, Esq., F.G.S.

The author referred to his previous descriptions of fishes from British Cretaceous rocks belonging to Prof. Cope's genera *Portheus* and *Ichthyodectes*, and stated that he had since obtained a form referable to the allied genus *Daptinus*. The specimen is in the collection of the British Museum, and was procured from the Grey Chalk of Dover by Mr. Gardner. It consists of the head and some vertebræ, the characters of which are described in detail by the author, who stated that in some characters, especially the degree of flattening of the teeth, the fish seems to stand between *Ichthyodectes* and *Daptinus*, and hence proposed to name it *Daptinus intermedius*. The author further noticed the existence in the British Museum of a right maxillary bone from the Lower Chalk of Dover, which he thinks may indicate a second species of the same genus.

3. "Further Remarks on Adherent Carboniferous Productidæ." By R. Etheridge, jun., Esq., F.G.S.

The author stated that since the reading of his former paper on this subject (Q. J. G. S. vol. xxxii. p. 454) his *Productus complectens* had been found in various localities, as in Northumberland, in Fifeshire, and near Dalry, in Ayrshire. The last-mentioned may be a distinct species. He further described two specimens of adherent Productidæ (one from Scremerston quarry, Northumberland, near Berwick, and one from Kinghorn, in Fifeshire) the characters presented by which led him to refer them to the genus *Chonetes*.

4. "The Submarine Forest at the Alt Mouth." By T. Mellard Reade, Esq., F.G.S.

The right of the remains of trees on the shore at Great Crosby, in Lancashire, to be regarded as representing a submerged forest having been called in question, the author desired to place on record the results of an investigation which, he thought, would dispose of all doubts on the subject. On cutting a trench through 1 foot of peat and 14 inches of clay round one of the stumps, which had an oak-trunk lying by it, apparently in the position in which it had fallen, the observers saw that roots were cut through all round, running along near the surface of the clay, or penetrating it diagonally; while rootlets and tap roots descended vertically into the clay. Several of the main roots were traced for a considerable distance into the clay. On raising the stump out of the ground, the clay showed numerous root-sections. The examination of the stumps gave confirmatory results.

April 17th, 1878.—Henry Clifton Sorby, Esq., F.R.S., President, in the Chair.

The following communication was read:—

"On the Palæontological Results of the recent Polar Expedition under Admiral Sir George Nares, K.C.B., F.R.S." By Capt. H. W. Feilden, R.A., F.G.S., and Robert Etheridge, Esq., F.R.S., F.G.S.

In this communication the authors brought before the Society the palæontological results and details of the collection made by the naturalists and other officers of the late expedition to the Arctic Circle under Admiral Sir G. Nares. The purpose of the paper was to record the presence of Silurian and Carboniferous fossils in the highest latitude yet reached, 82° 45′ N. Of the former group 60 species have been determined, ranging from the Lower to the Upper Silurian, both Llandeilo and Wenlock types being present and numerous—notably, in the class Heteropoda, two species of the genus *Maclurea*, and *Bellerophon*, with *Strophodonta* and *Raphistoma*, &c., also the genus *Receptaculites*. Upper-Silurian species of Actinozoa belonging to *Halysites*, *Favosites*, *Heliolites*, *Favistella*, *Zaphrentis*, *Amplexus*, *Cyathophyllum*, and *Arachnophyllum* were noticed, and correlated with British forms when possible; but, on the whole, the facies of the Cœlenterata is American rather than European. Amongst the Crustacea five genera were noticed:—*Bronteus*, *Calymene*, *Encrinurus*, and *Proëtus*, all Upper Silurian; and the genus *Asaphus*, associated with *Maclurea*, of Lower Silurian age. Ten species of Brachiopoda, belonging to the genera *Pentamerus*, *Rhynchonella*, *Chonetes*, *Atrypa*, *Strophomena*, have been determined.

Collections were made from twenty localities, ranging from lat. 79° 34′ to 82° 40′ N., notably the highest, at Cape Joseph Henry, where Capt. Feilden obtained a numerous Carboniferous-limestone fauna, numbering about thirty species, chiefly Brachiopoda and Polyzoa, all determined species, and American in character rather than British. Mr. Etheridge believed he had determined, through certain forms of Brachiopoda, the presence in a ravine at Dana Bay of the Devonian rock below the Carboniferous Limestone south of Cape Joseph Henry and Feilden Isthmus, the want of plant-remains preventing any correlation with the Ursa stage of Heer. It cannot now be doubted that an extensive Silurian fauna extends to, and is present from lat. 79° to lat. 82° N., illustrating both the lower and upper divisions of this group of rocks, especially the equivalents of our Wenlock series. Again, north of these there sets in a clearly defined Carboniferous-Limestone fauna, reaching the extremity of the highest latitude we know, and probably striking away beneath the Polar sea to Spitzbergen, where the same species have been described by Toula. The authors, through certain fossils, then endeavoured to show that on the whole the facies of the Polar palæozoic fauna was more nearly allied to that of America than to that of Europe, and thus must be correlated with it, although it was shown that a large number of species are common to the two areas, especially the British Islands. The absence of Lamellibranchiata in rocks older than the Tertiary was noticed as having special interest in the physical history of the Polar seas in Palæozoic and Mesozoic times. None have ever been detected in these rocks. The authors stated that they had sought also for evidence of Trias and Permian fossils in this and other collections made, but there appeared to be none. They also discussed the question of the deposition and extension of the Lias as represented at Eglinton Island and Spitzbergen. The authors furnished a Table showing the distribution of all the species collected by the expedition from twenty localities.

MISCELLANEOUS.

Probable Distribution of a Spider by the Trade-Winds.

Rev. H. C. M'Cook states that the *Sarotes venatorius*, Linn., a large laterigrade spider of the ballooning kind, occurs, according to specimens in his private collection, from Santa Cruz, Virgin Isles, to Cuba, Florida and Yucatan, Central America, Mexico and California, Sandwich Islands, Loochoo Islands and Japan, and thence across Asia and Africa to Liberia, and suggests, in view of these facts and other localities on record, that the trade-winds have promoted this distribution. Among the other localities are the Society Islands, Feejees, Friendly Islands, New Caledonia, Eastern Australia, Mauritius, Madagascar, and several parts of South America. He refers to a fact stated by Darwin, that at a distance of sixty miles from land, while the 'Beagle' was sailing before a steady light breeze, the rigging was covered with vast numbers of small spiders with their webs, each, when first coming into contact with the rigging, seated upon a single filament of spider-web, and so slenderly, in some cases, that a single breath of air was found to bear them out of sight. Mr. M'Cook states that the specimens examined by him show *no variations* which may not be accounted for "by differences in age, or which may not come within those ordinary natural differences which all animals more or less exhibit." But most of the specimens had lost their colours in the alcohol in which they were preserved.—*Proc. Acad. Nat. Sci. Philad.* 1878, p. 136.

On the Relation of Amœba quadrilineata *and* Amœba verrucosa.

Prof. Leidy stated that the small but characteristic amœboid form originally described by Mr. Carter (Ann. & Mag. Nat. Hist. 1856, xviii. p. 243) as *Amœba quadrilineata*, from specimens found in Bombay, he had repeatedly observed from many positions in our vicinity. In association with it he had noticed the singularly sluggish *Amœba verrucosa*, and also many intermediate forms, which led him to the belief that the former was the young of the latter. Subsequently, in reviewing the literature of the matter, he had been gratified to learn that Mr. Carter had arrived at the same result from a different point of view. In investigating the history of *Amœba verrucosa*, he found that its germs yielded young of the character he had previously described as *Amœba quadrilineata* (Ann. & Mag. Nat. Hist. 1857, xx. p. 37).

The forms described by Perty as *Amœba natans* (Kennt. kleinst. Lebensformen, 1852, p. 188), by Greeff as *Amœba terricola* (Arch. mikr. Anat. 1866, p. 299), and by Fromentel as *Thecamœba quadripartita* ('Études Microzoaires,' p. 346), he suspected to be the same as *Amœba verrucosa*.—*Proc. Acad. Nat. Sci. Philad.* April 1878.

On the Fossil Mammalia of South America. By M. P. Gervais.

Collections from the province des Mines, in Brazil, and from the Argentine Republic have recently been brought to Paris by MM. Ameghino, Brachet, and Larroque; and the author gives the following statement of some of the results of his examination of them.

With regard to *Toxodon*, he is able to add new details to those which we possessed upon this gigantic Mammal, the affinity of which with the Porcine Mammals now appears to him beyond doubt. Its habits must have been similar to those of the Hippopotami; but the singularity of its characters, which, however, are not foreign to those which distinguish those great Pachyderms of the Old World, must indicate more intimate allies still unknown.

The Jumentés have no well-marked representatives among the fossils of the region of La Plata, except the Horses known as *Hippidia*. With these, no remains of Tapirs have been found; but a fragment of a mandibular symphysis, still bearing the traces of two canines between which two incisors were implanted, would seem to indicate an animal resembling the Rhinoceroses, at least as regards this part of its dental formula.

A large *Machairodus*, resembling in its size and the great development of its upper canines the Brazilian *Machairodus neogæus* (*Felis smilodon*, Blainv.), nevertheless seems to form a distinct species, judging from differences in the form of the skull, and the number of its lower molars, of which there were only two, instead of three. It may be called *Machairodus necator*. M. Larroque has the skeleton of this animal nearly complete.

A more complete comparison of the carapaces of several species of Glyptodonts, and of certain parts of the skeleton of these animals, confirms their separation into several genera proposed by Burmeister, and shows that the number of species was certainly more than ten.

One of the Glyptodonts previously brought over by M. Seguin has not yet been described. Its bony plates are quadrangular, rough on the outer surface, but without rosaciform tubercles, and without rays. The rings of its caudal sheath are formed of separate pieces, the interlockings (*guillochures*) of which resemble those of the dorsal pieces. This Glyptodont, of which the cephalic armature has also been brought, will no doubt constitute a distinct genus. It was discovered in the province of Santa-Fé; and the author for the present gives it the name of *Glyptodon rudis*.

Another undescribed species is more allied to *Hoplophorus*, but differs from the known species of that genus by its plates, which are composed of a smooth central disk of polygonal form with very blunt angles, and bearing on its sides smaller smooth plates in the form of arcs of a circle. This *Hoplophorus*, of which only a small fragment is known, is named by the author *H. discifer*; it is in M. Ameghino's collection.

The author adds that M. Ameghino has brought home a considerable number of objects of human workmanship, both in bone and stone, produced by the first inhabitants of the Argentine Territory. Some of these specimens appear to him to date back to the period of the great Mammals, in which case they will furnish fresh evidence of the coexistence of man with extinct animals.—*Comptes Rendus*, June 3, 1878, p. 1359.

THE ANNALS

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[FIFTH SERIES.]

No. 10. OCTOBER 1878.

XXXII.—*On the* Willemoesia *Group of Crustacea.* By C. Spence Bate, F.R.S.*

[Plate XIII.]

Among the many objects of interest taken from the depths of the ocean during the cruise of the 'Challenger,' there were few that attracted more attention than the so-called blind Crustacea.

These were described by Mr. Willemoes-Suhm rather fully both in 'Nature' and in the 'Transactions of the Linnean Society,'—in the pages of the former under the name of *Deidamia*; but in the latter Mr. Grote, having discovered that this name had been in use for a genus of Sphingidæ, changed it to *Willemoesia*, in compliment to the unfortunate marine zoologist of the expedition.

Soon after it had been published it was recognized by those who had given attention to the subject to resemble a small crustacean that Dr. Heller had described among the "Crustaceen des südlichen Europa," from a single male specimen in the collection of the museum at Vienna, to which he gave the name of *Polycheles typhlops*, belonging to the same group. I believe that I am correct in stating that Mr. Wood-Mason was the first, in the 'Journal of the Asiatic Society' for 1875, to point out the resemblance between of *Polycheles* of Heller and *Willemoesia* of the 'Challenger' expedition.

* Read at the Meeting of the British Association at Dublin, on Monday, Aug. 19, 1878. Communicated by the Author.

Each of these zoologists has described the animal as being blind; and it is supposed that on this character Heller founded the specific name of his species, the eyes of which, he says, are rudimentary; and Willemoes-Suhm says that "*the eyes are entirely wanting*, nor is there any place left open where you might expect to find them."

Both these observant naturalists have passed over the peculiar character of the organ of vision that belongs to this group of animals. Heller has classified it with the family Astacidæ in a division by itself; and they have both asserted that it closely corresponds with the fossil genus *Eryon*.

Dr. Camil Heller, moreover, says that it bears a strong resemblance in the form of the body to the Scyllaridæ, from which it differs essentially by the structure of the antennæ, the form of the chelæ, and the narrow sternum. With the Astacidæ it has in common the possession of the leaf-like appendage at the base of the second antennæ and the chelate character of the pereiopoda; in all other respects it differs from *Astacus*.

Willemoes-Suhm says, "Among the living Decapoda Macrura there is hardly a group with which *Willemoesia* could be said to be very closely allied. Nearest to it are undoubtedly the Scyllarinæ; but these, like all the genera of the family Palinuridæ, differ from it in the absence of the lamellar appendage of the second antennæ, and in the presence of palpi at the base of the gnathopoda, which, as we have seen, are wanting in this new genus. Nor can it, for this latter reason, be referred to the Astacidæ, with which it has in common the presence of the antennal scale."

"The genus," says Heller, "corresponds greatly with the fossil crustacean described by Deshayes from the slate-quarries of Solenhofen (*Eryon Cuvieri*), since also in this are found a flattened carapace and similarly formed antennæ and pereiopoda. The hinder part of the body is much narrower than the anterior; and the leaf-like appendage of the second pair of antennæ is much enlarged. It forms a link between the Scyllaridæ on the one hand, and the Astacidæ on the other."

"It is very astonishing, indeed," says Willemoes-Suhm, "that, among all the crustaceans known to us, *Willemoesia* approaches most closely the fossil Eryontidæ. If we compare, for example, our figure of *W. crucifera* with the figure of *Eryon arctiformis*, and the description of the 'Tribu des Eryons' given by Milne-Edwards (and probably taken especially from Desmarest's 'Crustacés Fossiles'), we find most striking resemblances between the two forms. In *W. crucifera* as well as in *Eryon* the carapace has nearly half the length of the whole body; and in both forms its lateral borders are wing-like expansions which are divided by two deep incisions into three portions. The anterior border of the carapace is nearly straight in both forms.

"*Eryon* was probably not blind; for the eye-stalks have been found in several specimens. Its antennæ seem to be somewhat more reduced than in *Willemoesia*; but the second pair of them has, according to Desmarest, 'une écaille assez large, ovoïde et fortement échancrée.' This is the chief difference between *Eryon* and the Palinuridæ, and the same in which *Willemoesia* also differs from that group."

So much do the fossil and recent animals resemble each other that the discoverer of the recent species says, "If the last pair of pereiopoda and the pleon of *Eryon* were presented to me I should undoubtedly declare them to be parts of the genus *Willemoesia.* There are the same line of spines at the top of the rings, the same wing-like expansions on both sides, and that characteristic 'caudal apparatus.' Also the fine fringe of hairs which distinguishes the caudal fin of *Willemoesia* is to be seen in the fossil crustacean."

"*Eryon*," continues the same author, "differs from the living genus chiefly by the presence of eye-stalks and of palpi at the base of the gnathopoda. According to Quenstedt the latter were observed only with difficulty; and their presence seems not to be beyond all doubt." And the lamented carcinologist of the expedition looked forward to his return, when he would look over the original specimens and satisfy himself, so as to enable him to give a more detailed account of the relations of *Willemoesia* to *Eryon.* That they must be very close he had no doubt, and considered that among the Eryontidæ this new genus must take its place, between the Astacidæ and Palinuridæ.

It will be desirable that we should examine the animals and see how far the conclusions arrived at by two independent observers can be supported by extended inquiry.

Heller describes *Polycheles* as having a thin dermal structure, *rudimentary* eyes, antennæ like those of *Willemoesia*, and four pairs of pereiopoda chelate, and one (the fifth pair) simple.

Willemoes-Suhm describes *Willemoesia* as having the eyes and eye-stalks *entirely wanting*; four or five pairs of pereiopoda chelate in distinct species.

In all other respects the descriptions of the two authors agree.

The 'Challenger' collection contains specimens of this group from thirteen different places; and in every one I was able, upon close examination, to find the eyes very distinct, though singularly situated. Moreover there is a variation in form and position that gives them a value in classification, particularly when taken into consideration with the relative forms of the several pairs of pereiopoda.

The dorsal surface of the several species of this group is flattened and depressed, and the anterior margin is tolerably straight; the central tooth, which is sometimes single and sometimes double, is never directed forwards in the form of a rostrum, but upwards and obliquely forwards. In the anterior margin on each side there is a deep cleft in the dorsal surface, in which the eye with its peduncule is lodged; the anterior extremity being directed forwards, outwards, and downwards, is covered over by the lateral projecting wings of the carapace. It appears to have two points of vision, the one upwards by the dorsal surface, the other downwards and outwards by the lens at the extremity of the peduncle. But these several points are liable to vary in degree. In some the dorsal notch is almost non-existent, in others it is very deep; and it is by this variation, taken in connexion with the power of change in the form of the pereiopoda, that I purpose classifying the several species of this interesting group.

Polycheles, Heller.

(Crust. des südl. Europa.)

In this genus I accept the author's definition, that it has the anterior four pairs of pereiopoda chelate and the fifth simple. But instead of saying that the eyes are rudimentary, I assert that they are immovably lodged in a notch in the dorsal surface of the carapace, with the anterior extremity projecting beneath the antero-lateral wing of the carapace.

Pentacheles, n. g.

All the pereiopoda are chelate, and the eyes are lodged immovably in a notch in the antero-dorsal surface of the carapace, with the anterior extremity projected beneath the antero-lateral wing-like extremity of the carapace.

Willemoesia, Grote.

(Nature, October 1873.)

All the pereiopoda chelate, and the eyes immovably situated in the anterior or frontal surface of the cephalon, and neither lodged in a notch in the dorsal surface of the carapace nor covered by the antero-lateral wing of the carapace. Eyes small, directed outwards and forwards.

Of the genus *Polycheles* there are three species in the collection of the 'Challenger' expedition; and of these I take as the type of the group the specimen that has been named by Willemoes-Suhm *W. crucifera.* It agrees with Heller's figure in having but a single rostriform tooth, but differs from it in general form; but it stands, according to its general structure, at the opposite extremity of a series of intermediate forms to *Willemoesia leptodactyla.*

Polycheles crucifer (Willemoes-Suhm).

Willemoesia crucifera, Willemoes-Suhm, Linn. Trans. vol. i. 2nd series, p. 52, pl. xii. fig. 10, pl. xiii. figs. 10, 11.

Carapace ovate, margins fringed with large teeth; frontal margin armed with a single rostriform tooth and two sharp smaller teeth at the inner angle of the orbital notch; dorsal ridge without teeth, but nodulated, as well as the dorsal surface, where the nodules run in lines corresponding with the limits of the internal osseous formation. Pleon with a spinous carina traversing the median line, each somite being armed with two strong teeth. The eye is lodged in a narrow cleft of the carapace, and projected beneath the antero-lateral wing in the form of a long obtuse point.

This species was taken in the West Indies, off Sombrero Island, at a depth of 450 fathoms, on a bottom of *Globigerina*-ooze. Length 1½ inch.

Polycheles Helleri, n. sp.

Lateral margins of the carapace subparallel; anterior division armed with seven teeth, median with four, and posterior with many, decreasing in size posteriorly; dorsal central ridge armed with two rostral teeth, two median, and two on the posterior margin, with a few intermediate. The pleon is carinated on the five anterior somites, the anterior median portion of each somite culminating in an anteriorly directed point. Eye lodged in a deep notch, with the inner and outer canthus smooth. Meros of the first pair of pereiopoda armed on the outer side with two teeth, and on the inner with one or two smaller ones.

This species was first taken in lat. 29° 55′ S., long. 178° 14′ W., near Kermadec Island, three or four degrees north of

New Zealand, at a depth of 520 fathoms, on hard ground, where the sea-temperature at the bottom was 6° C.

A fine specimen was also taken 2000 miles from the last place, in lat. 2° 33′ S., and long. 144° 4′ E., north of New Guinea, at a depth of 1070 fathoms, on *Globigerina*-ooze, with a bottom-temperature of 2°·1 C.

Polycheles baccatus, n. sp.

Lateral margins of the carapace subparallel; anterior division armed with twelve teeth, median with five, and posterior with many, extending to the posterior margin; anterior margin serrated and armed with teeth on the inner side of the antero-lateral angle; central ridge projected into a rostriform tooth supported by two small teeth; median dorsal ridge without teeth or spines; but a few bead-like points fringe the posterior part of the median line and the posterior margin. Pleon carinated on each of the four anterior somites and projected into an anteriorly pointed tooth. Eye lodged in a deep notch in the antero-dorsal surface of the carapace. Meros of the first pair of pereiopoda smooth, except a small tooth on the outer distal angle.

This species was taken in lat. 19° 10′ S., long. 179° 40′ E., near the Fiji Islands, at a depth of 310–315 fathoms, on a bottom that is marked "r.c." in the plans.

Pentacheles differs from *Polycheles* in having the last pair of pereiopoda always more or less perfectly chelate.

Pentacheles lævis, n. sp.

Carapace ovate; lateral margins serrated conspicuously at the anterior extremity, the serration gradually decreasing in importance posteriorly; frontal surface having the inner canthus of the orbit produced to a prominent tooth, and two rostral teeth in the median line, behind which, on the median ridge, there are two small teeth; the rest of the dorsal surface is smooth. Pleon slightly carinated, but not very distinctly so. Posterior pair of pereiopoda imperfectly chelate.

Taken in lat. 4° 33′ N., long. 127° 6′ E., at a depth of 500 fathoms, on a bottom of *Globigerina*-ooze with a temperature of 5°·3 C., south of the Philippine Islands.

Pentacheles Suhmi, n. sp.

Carapace with lateral margins subparallel; anterior division armed with five strong teeth, median with two, and posterior with eight or nine strong teeth that are continuous to the posterior margin; frontal margin having a single sharp tooth on the inner side of the orbital angle, and two central rostral teeth, posterior to which are two single and two double teeth on the central dorsal ridge of the anterior portion of the carapace; two teeth closely set are situated on the anterior and posterior extremities of the central ridge. The pleon is carinated, each somite being formed into two unequal teeth, the anterior being the longer and most anteriorly projecting.

Taken in lat. 47° 48′ S., long. 74° 48′ W., on the west coast of Patagonia, 120 fathoms, in mud.

Pentacheles gracilis, n sp.

Carapace long, ovate; lateral margins evenly denticulated from the anterior to the posterior extremities; anterior division armed with nine teeth, the median with three, and the posterior with fifteen; the frontal margin has two rostriform teeth, and one still more prominent at the inner canthus of each orbit. The median longitudinal dorsal ridge armed through the entire length with a single row of sharp teeth, of which the anterior are the more prominent. Pleon carinated, but only the three anterior somites are armed with sharp cusps. Anterior pair of pereiopoda having several small spines on the inner margin of the meros; posterior pair unequally chelate.

Taken in lat. 19° 10′ S., long. 179° 10′ E., off the Fiji Islands, at a depth of from 210 to 610 fathoms, on a bottom of *Globigerina*-ooze, with a temperature of the sea-bottom of 3°·7 C.

Pentacheles obscurus, n. sp.

Carapace with the lateral margins parallel and unevenly denticulated; frontal margin with two central rostriform teeth; divisions of the carapace not well-defined, anterior with three or four small teeth separated from each other, median with three similar teeth, and the posterior with five or six. Anterior pair of pereiopoda with the meros short and smooth; posterior pair unequally chelate. Pleon carinated, tuberculous in the median line.

Taken in lat. 2° 33′ S., long. 144° 4′ E., north of New Guinea, at a depth of 1070 fathoms, at a temperature of 2°·1 C., on a bottom of *Globigerina*-ooze.

The only specimen of this species was in a very imperfect condition, being apparently an animal that had but recently shed its skin.

Pentacheles auriculatus, n. sp.

Carapace with the lateral margins nearly parallel; anterior division with five teeth, median with three, and posterior with five or six; frontal margin with two long rostriform teeth near the centre, and one small one above the inner angle of the orbit. Median dorsal ridge strongly denticulated on the anterior portion, and having two double spines on the posterior, and a single tooth on each side of the median line on the posterior margin. Pleon carinated, with the ridge on the third and fourth somite produced to a long anteriorly curved sharp point. Anterior pair of pereiopoda with meros smooth on the inner surface and one tooth on the outer near the base, and one near the apex; posterior pair chelate, with unequal dactyla. Coxal plates ridged with markings like small ears.

Taken in lat. 19° 10′ S., long. 178° 10′ E., at a depth of 610 fathoms, off Fiji, on a bottom of *Globigerina*-ooze.

Pentacheles enthrix (Willemoes-Suhm, MS.).

Carapace with lateral margins slightly convex; anterior division with eight teeth, median with four, and posterior with twelve or fourteen. Frontal margin with two rostriform teeth, and a few unequally small teeth between them and the orbital notch; a few single and double teeth along the median dorsal ridge, two on the central median ridge, and three on each side of the median ridge on the posterior margin. Pleon dorsally carinated and evenly cusped. Anterior pair of pereiopoda with two spines on the outer side of the meros; posterior pereiopoda evenly chelate.

Taken in lat. 29° 55′ S., long. 178° 14′ W., on hard bottom, at a depth of 520 fathoms, and in lat. 19° 10′ S., long. 179° 40′ E., at a depth of 315 fathoms.

Willemoesia leptodactyla.

Willemoesia leptodactyla, Willemoes-Suhm, Linn. Soc. Trans. vol. i. 2nd ser. p. 50, pl. xiii. figs. 1–9.

Carapace with the lateral margins subparallel or slightly convex; anterior division with six teeth, median with four, and the posterior with fifteen. Frontal margin with slight orbital notches, and a single rostriform tooth in the centre. Median dorsal ridge armed with a few sharp teeth. Pleon carinated, each of the five outer somites having a sharp anteriorly directed tooth. Anterior pair of pereiopoda having the outer margin of the meros smooth, and the inner fringed with small spines, and a large anteriorly directed tooth on the inner surface of the dactyloid process of the propodos. Pleon carinated, the five anterior somites produced into sharp, anteriorly pointed cusps.

Taken in lat. 21° 38′ N., long. 44° 39′ W., at a depth of 1900 fathoms, in the middle of the North-Atlantic Ocean, on a bottom of *Globigerina*-ooze, with a bottom-temperature of 1°·9 C., and near the island of Juan Fernandez, at a depth of 1375 fathoms on *Globigerina*-ooze, 1°·8 C.

		fathoms.	Temp.	
POLYCHELES.				
crucifer	West Indies.	450	..	*Glob.*-ooze.
Helleri	Kermadec Isl.	520	6°	Hard.
„	New Guinea.	1070	2°·1	*Glob.*-ooze.
baccatus............	Fiji.	310	..	r.c.
typhlops	Mediterranean.			
PENTACHELES.				
lævis	Philippine Isl.	500	5°·3	*Glob.*-ooze.
Suhmi	Patagonia.	120	..	Mud.
gracilis	Fiji.	610	3°·7	*Glob.*-ooze.
obscurus	New Guinea.	1070	2°·1	*Glob.*-ooze.
auriculatus	Fiji.	610	..	*Glob.*-ooze.
enthrix	New Hebrides.	315	..	r.c.
WILLEMOESIA.				
leptodactyla	North Atlantic.	1900	1°·9	*Glob.*-ooze.
„	Juan Fernandez.	1375	1°·8	*Glob.*-ooze.

The eyes of the several genera although they may differ from each other in structural detail, yet correspond throughout the group in a common characteristic. The peduncle is reduced to a minimum and fixed as a rigid part of the dermal structure, over which a portion of the carapace is projected.

If we turn to the animal while it is yet embryonic (and our only opportunity is its observation before it has quitted the egg) although in an advanced condition, we see that previously to the eruption from the ovum it attains at least the zoëa stage of development, and that the eyes are large and distinctly pedunculated, just in the same way as the zoëa of *Alpheus* in the embryonic condition has eyes considerably larger and more like the permanent organ in other genera than the adult parent from which it springs.

The alteration from the original type to a depauperized condition is therefore due to a cause acting through the habits of the animal after it has passed through its zoëa stage. This is precisely the way that *Alpheus* has passed; and as the result has been somewhat similar, it is highly probable that the conditions have been parallel.

Alpheus in the young stage is a free-swimming animal with powerful organs of vision; but in its adult condition it burrows in the mud of the sea-bottom, where the eye is of little use, except to see things in close proximity, and where it is liable to injury from rough accidents, unless it were protected, as it is, by the strength of the overlying carapace.

The history of *Willemoesia* and its allies I believe to be very parallel with that of *Alpheus*. In its young stage it has well-developed eyes, which it loses when it has arrived at its adult condition. This I believe to be attributable to a similar cause, viz. that it burrows in the soft mud of the deep-sea bottom.

This is borne out by an examination of the contents of the stomach, which I found to be full of the remains of the structures found in the *Globigerina*-ooze.

That the depauperized state of the organs of vision is not due to the loss of light from the great depth at which *Willemoesia* is taken is evident from the fact that *Thalascaris*, n. g. (Crangonidæ), is taken at depths equally great, and is remarkable for the large size of its eyes.

Willemoesia, moreover, is not one of our deepest sea inhabitants. *Willemoesia leptodactyla* was taken both in the Atlantic and Pacific at a depth of 1900 and 1375, while *Polycheles Helleri* and *Pentacheles obscurus* were taken north of New Guinea at a depth of 1070; yet most of the other species, even including *Polycheles Helleri*, were taken at depths between 610 and 120 fathoms.

The bottom temperature has only been recorded in seven of the stations at which the species were taken—that is, only from the deeper soundings; these, however, vary from 6° to 1°·8 C. I am therefore inclined to think that temperature can only be second to that of the character of the sea-bottom itself.

Out of the thirteen stations from which specimens of this group have been recorded, the bottom consists of what has been named *Globigerina*-ooze in eight, one is recorded of mud, and two "r.c." (which, I suppose, means red clay), and one only on hard ground; but as this occurs only once, and that with an animal (*Polycheles Helleri*) that is also recorded from another station where *Globigerina*-ooze exists, I think that we may safely infer that the whole group are inhabitants of a soft bottom, preferring that in which animal life suitable for their existence abounds, and that their general structure and form are in accord with their habitat.

EXPLANATION OF PLATE XIII.

Fig. 1. *Pentacheles enthrix.*
Fig. 2. The same : eye, seen from beneath.
Fig. 3. The same : chela of the posterior pair of pereiopoda.
Fig. 4. *Willemoesia leptodactyla* : anterior portion of one side of the carapace, showing eye and 1st and 2nd antennæ.
Fig. 5. The same : frontal margin of carapace, showing eyes, seen in front.
Fig. 6. *Polycheles crucifer* : anterior portion of one side of carapace, showing eyes and the 1st and 2nd antennæ, seen from above.
Fig. 7. The same : eye, seen beneath and in front.
Fig. 8. The same : fifth pair of pereiopoda.

XXXIII.—*On a Collection of Lepidoptera recently received from Madagascar.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

The Lepidoptera here enumerated were collected by the Rev. William Dean Cowan.

The series of butterflies in the collection represents rather less than one third of those hitherto recorded as occurring in Madagascar; and, owing to the careful manner in which Mr. Cowan has recorded upon each envelope all facts known to him respecting the species therein contained, not a little information respecting the habits and distribution of the Mascarene forms has been gained.

The collection contains forty-one butterflies and fifteen moths, as follows.

Rhopalocera.

Nymphalidæ.

Satyrinæ, Bates.

Mycalesis, Hübner.

1. *Mycalesis ibitina.*

Mycalesis ibitina, Ward, Ent. Mo. Mag. x. p. 60 (1873).

One female found in the forest, Fianarantsoa.

This is the first time that I have seen this species. It is a singular form, having the under surface of the secondaries clouded and striated like a *Pedaliodes*.

2. *Mycalesis perdita*, n. sp.

Upper surface chocolate-brown, with a slight purple gloss; secondaries with an ill-defined blackish submarginal line. Wings below a little paler than above, with the exception of a broad central belt bounded by darker lines, the inner line arched and sinuous on each wing, the outer line irregularly zigzag; a submarginal blackish line: primaries with whity-brown internal area; a very minute black ocellus with white pupil and ochreous iris near the apex, and an ocellus similarly coloured, but of about six times the size, on the first median interspace: secondaries with a white-pupilled black ocellus on the first median interspace, followed on the second interspace by a much smaller (almost punctiform) ocellus, and on the subcostal interspaces by three white dots. Expanse of wings 1 inch 10 lines.

♂. Caught in the forest, Fianarantsoa.

This species seems to be allied to "*Erebia*" *passandava* of Ward; but in the colouring of the upper surface and position of the ocelli it differs from that butterfly.

Ypthima, Westwood.

3. *Ypthima Batesii.*

Ypthima Batesii, Felder, Reise der Nov. Lep. iii. tab. 68. figs. 10, 11 (1867).

♂. Found only in the forest, Fianarantsoa.

Nymphalinæ, Bates.

Heteropsis, Westwood.

4. *Heteropsis drepana.*

♂. *Heteropsis drepana*, Doubleday and Hewitson, Gen. Diurn. Lepid. pl. 63. fig. 5 (1850); ♀, Hewitson, Ent. Mo. Mag. xi. p. 227 (1875).

One female. Ankafana, Betsileo.

This singular species, with its acuminate primaries and rounded secondaries, I have hitherto only known from the figure of the male. To my mind it has been wrongly located in the Satyrinæ; it seems to find a natural position near *Cœnophlebia* and *Siderone*, notwithstanding its more slender antennæ and the general coloration of the male. The colouring of the female is quite as near to that of *Tenaris* as to that of any Satyrid, and the leaf-like under surface agrees with that of the group to which I propose to transfer it.

Coryphæola, n. gen.

Allied to *Paphia*, *Kallima*, and *Doleschallia*; the form of the wings in the male like *Kallima*, that of the female more like *Doleschallia* owing to the apex being obliquely truncate; the secondaries of both sexes terminating in a long tail continuous with the abdominal margin; antennæ more abruptly clubbed than in the genera with which I have compared it. Type *C. eurodoce.*

5. *Coryphæola eurodoce.*

Kallima eurodoce, Westwood, Gen. Diurn. Lepid. p. 325 (note), pl. 54*. fig. 1 (1850).
Doleschallia eurodoce, Kirby, Cat. Diurn. Lepid. p. 193 (1871).

Found only in the forest, Ankafana.

CHARAXES, Ochs.

6. *Charaxes Cowani,* n. sp.

Allied to *C. candiope*, but altogether smaller and darker, with smaller tawny spots; basal half of wings above deep fulvous-tawny; apical half dark chocolate-brown (almost black) with an undulated ferruginous border; primaries with apex more acuminate than in *C. candiope*; veins of the costal border tinted with green as far as the middle of the wing; discoidal lines normal; an ill-defined ferruginous spot just beyond the cell, above and beyond which are two or three subconfluent spots of the same colour; a sinuous discal series of seven dark tawny spots, smaller than in *C. candiope*; marginal ferruginous border interrupted near the external angle: secondaries with the abdominal half of wing dusky, the depression whitish to the end of the body; blackish apical area broader than in *C. candiope*, and with a straight inner edge; eight submarginal transverse dark tawny dashes, the last four of which are followed by lilac spots bounded externally by black and green crescents; the margin much more strongly dentated than in the African species, and the tails more slender and acuminate, the inner one slightly curved outwards (as in *C. antamboulou*). Colouring of the under surface more uniform than in *C. candiope*, the two discal ocelloid patches and a belt crossing the middle of the discoidal cell being the only yellowish portions of the primaries, and the secondaries having no trace of either the green patch or the yellow belt which follows it; costal border and veins of primaries tinted with green. Expanse of wings 3 inches 2 lines.

Found in the forest, Fianarantsoa.

This species is allied to *C. antamboulou*† of Lucas; the

† I much regret to see the gradual increase in the number of these unwarrantable names amongst butterflies; in one page of Kirby's catalogue the following occur:—*Pamphila metacomet, P. ahaton, P. wamsutta, P. monoco, P. kiowah, P. pontiac*—names which may either be meant for jokes, or be given in honour of savage chieftains; no explanation accompanies them. If *met-a-comet* and *a-hat-on* are tolerated by scientific men, I presume that any thing would equally pass muster.

latter, however, seems to be more nearly allied to *C. candiope*, excepting that no mention is made of the discal series of tawny spots.

JUNONIA, Hübner.

7. *Junonia andremiaja.*

Vanessa andremiaja, Boisduval, Faun. Madag. p. 45. n. 6 (1833).

♂. Fianarantsoa.

This species has been supposed to be the female of *J. musa*, but only because it agrees with that species in the form of its wings. The sexes of both are common in collections; but nobody seems to have troubled himself to examine their sexual characters, and therefore the error has remained unchallenged. In the present series *J. andremiaja* is a male and *J. musa* a female.

J. andremiaja is said by Mr. Cowan to be "common in houses on warm days."

8. *Junonia musa.*

Vanessa musa, Guérin, Icon. Règne Anim. Ins. texte, p. 474 (1844).

♀. Fianarantsoa.

"Very common near Fianarantsoa; can be caught in hundreds, in any shady place, during the heat of the day. The chrysalis has brilliant silvery spines."

9. *Junonia rhadama.*

Junonia rhadama, Boisduval, Faun. Madag. p. 44. n. 4, pl. 7. fig. 2 (1833).

♂ ♀. Very common. Betsileo.

10. *Junonia epiclelia.*

Vanessa epiclelia, Boisduval, Faun. Madag. p. 44. n. 2, pl. 7. fig. 3 (1833).

♂. "Common."

"Bred by me: fifteen days in chrysalis of a dark colour" (*Rev. W. D. Cowan*). Chiefly differs from *J. clelia* in the narrower cream-coloured markings of the upper surface.

PYRAMEIS, Hübner.

11. *Pyrameis cardui.*

Papilio cardui, Linnæus, Faun. Suec. p. 276. n. 1054 (1761).

"Very common round the house, flitting about in the sun" (*Rev. W. D. Cowan*).

Salamis, Boisduval.

12. *Salamis Duprei.*

Salamis Duprei, Guénée, in Vinson's Voy. Madag. Lep. p. 573, pl. 5 (1865).

In the forest, Ankafana.

The figure of this species represents an imperfect example, from which the tails of secondaries have been broken off.

Aterica, Boisduval.

13. *Aterica rabena.*

Aterica rabena, Boisduval, Faun. Madag. p. 47, pl. 8. fig. 2 (1833).

"Found in the Tanala, in shades by the river; not found here" (*W. D. C.*).

Hypolimnas, Hübner.

14. *Hypolimnas misippus.*

Papilio misippus, Linnæus, Mus. Lud. Ulr. p. 264 (1764).

♂. "Found commonly on bare uplands, mostly near summits. Fianarantsoa."

Hypanis, Boisduval.

15. *Hypanis anvatara.*

Hypanis anvatara, Boisduval, Faun. Madag. p. 56, pl. 7. fig. 5 (1833).

"Takarana."

Acræinæ, Bates.

Telchinia, Doubleday.

16. *Telchinia manjaca.*

Acræa manjaca, Boisduval, Faun. Madag. p. 33. n. 9, pl. 4. fig. 6, pl. 5. figs. 6, 7 (1833).

♂ ♀. Fianarantsoa.

"Feeds on a species of *Labiata.* Thirteen days in chrysalis. Common."

17. *Telchinia lycia.*

Papilio lycia, Fabricius, Syst. Ent. p. 464. n. 94 (1775).

"Found on grassy uplands. Betsileo."

Acræa, Fabricius.

18. *Acræa zitja.*

Acræa zitja, Boisduval, Faun. Madag. p. 32. n. 7, pl. 4. figs. 4, 5 (1833).

"Common about cultivated places."

19. *Acræa calida*, n. sp.

Allied to the preceding species, much smaller, with no regular black border to the outer margin: the primaries with longitudinal streaks running from the margin up the nervures to near the middle of the disk; a large black spot upon the discocellulars and three smaller ones in an oblique series halfway between the cell and the margin: secondaries with a blackish patch divided by the median vein at the base; a black spot above the cell, two in the cell, one below it and one discocellular; a curved discal series of seven small black spots; a marginal series of six triangular blackish spots terminating the nervures. Veins below black, with cream-coloured borders: primaries with a cream-coloured dash from the front of the discal black dots: secondaries with the discoidal cell, a dash on the second median interspace, and a narrow regular external border cream-coloured; the black discal spots of the upper surface only represented by one spot at the abdominal margin; the basal blackish patch and the marginal spots (as also the longitudinal dashes of the primaries) wholly wanting. Expanse of wings 1 inch 9 lines.

♀. Fianarantsoa.

Mr. Cowan says that this species is "common;" unfortunately he has only sent one example.

20. *Acræa punctatissima.*

Acræa punctatissima, Boisduval, Faun. Madag. p. 31. n. 5, pl. 6. fig. 2 (1833).

"Common on grassy plains." Fianarantsoa.

21. *Acræa obeira.*

Acræa obeira, Hewitson, Proc. Zool. Soc. 1863, p. 65.

♀. "Found near towns."

22. *Acræa piva.*

Acræa piva, Guénée, in Vinson's Voy. Madag. Lep. p. 34 (1865).

♀. "Common." Fianarantsoa.

This species is extremely close to the preceding, but is larger and redder, and the border of the secondaries is interrupted by large red spots.

Erycinidæ.

Nemeobiinæ, Bates.

Saribia, n. gen.

Allied to *Abisara*, but the secondaries tricaudate; two rather slender tails emitted at the termination of the first and second median branches, and a third shorter one at the anal angle. Type *S. tepahi.*

23. *Saribia tepahi.*

Emesis tepahi, Boisduval, Faun. Madag. p. 27, pl. 3. fig. 4 (1833).

"Found only in the forest by the pathway. Betsileo."

Lycænidæ.

Lampides, Hübner.

24. *Lampides lingens.*

Papilio lingens, Cramer, Pap. Exot. iv. pl. 379. figs. F, G (1782).

♂ ♀. "Found in the forest. Ankafana."

25. *Lampides pulcher.*

Lycæna pulchra, Murray, Trans. Ent. Soc. 1874, p. 524, pl. 10. figs. 7, 8.

♂. "Found amongst grass. Fianarantsoa."

26. *Lampides bœticus.*

Papilio bœticus, Linnæus, Syst. Nat. i. 2, p. 789. n. 226 (1767).

♂. "Found amongst grass. Fianarantsoa."

27. *Lampides catharina.*

Lycæna catharina, Trimen, Trans. Ent. Soc. ser. 3, vol. i. p. 281 (1862).

"Common on grassy plains. Fianarantsoa."

28. *Lampides aberrans*, n. sp.

♂. Above like the preceding species, excepting that the orange spots of secondaries are much smaller. Wings below pale greyish brown, whitish towards external angle; a black discocellular line edged with white; two white-edged black spots on the median interspaces, followed by white-edged crescents of the ground-colour: secondaries with a black discocellular line; a longitudinal fusiform black spot above the cell, followed by three black dots, a fusiform spot in the cell, and one or two small spots on the space between the first and second subcostal branches, all white-edged; outer border marked with whitish orange and green-speckled black dots as in the preceding species. Expanse of wings 1 inch 4 lines.

"Found in grass. Fianarantsoa."

Lycæna, Fabricius.

29. *Lycæna knysna.*

Lycæna knysma, Trimen, Trans. Ent. Soc. ser. 3, vol. i. p. 282 (1862).

Fianarantsoa.

30. *Lycæna atrigemmata*, n. sp.

Wings above bright lavender-blue, with rather narrow dark brown borders; fringes whitish flecked with brown: secondaries with an ill-defined series of submarginal brown dots: body blackish; antennæ white, with brown annulations above. Wings below pale greyish brown, with a double marginal series of white-bordered dusky spots, the sixth and eighth of the external row on the secondaries with black centres; the inner row lunate: primaries with two subcostal dots at the middle of the wing, a large round spot in the cell, a second closing the cell, and four (the lowermost one small) beyond the cell in a transverse series, black with white borders: secondaries with a small spot at the base, a lunule closing the cell, and an annular series of eleven spots surrounding it black, bordered with white: body below whitish. Expanse of wings 9 lines.

"Found amongst grass. Fianarantsoa."

Papilionidæ.

Pierinæ, Bates.

Mylothris, Hübner.

31. *Mylothris phileris.*

Pieris phileris, Boisduval, Faun. Madag. p. 17. n. 2, pl. 2. figs. 3, 4 (1833).

"Very common. Fianarantsoa."

NYCHITONA, Butler.

32. *Nychitona sylvicola.*

Leucophasia sylvicola, Boisduval, Faun. Madag. p. 20 (1833).

"Common in dark shades of the forest. Fianarantsoa."

TERIAS, Swainson.

33. *Terias pulchella.*

Xanthidia pulchella, Boisduval, Faun. Madag. p. 20. n. 1, pl. 2. fig. 7 (1833).

♂ ♀. "Common on bare ground. Betsileo."

34. *Terias Desjardinsii.*

Xanthidia Desjardinsii, Boisduval, Faun. Madag. p. 22. n. 3, pl. 2. fig. 6 (1833).

"Seen everywhere. Fianarantsoa."

CATOPSILIA, Hübner.

35. *Catopsilia thauruma.*

Callidryas thauruma, Reakirt, Proc. Acad. Nat. Sci. Phil. 1866, p. 238. n. 4; Butler, Lep. Exot. pl. xxii. figs. 3–6 (1870).
C. fiaduna, Hewitson, Exot. Butt. iv. *Call.* pl. i. figs. 1–4 (1867).

♂ ♀, Ikaryosoa. ♀, Fianarantsoa.
Said to be common at Fianarantsoa in January, and to have a strong flight.

BELENOIS, Hübner.

36. *Belenois helcida.*

Pieris helcida, Boisduval, Faun. Madag. p. 17. n. 1, pl. 2. figs. 1, 2 (1833).

"Very common in Tanala in August; rare at Fianarantsoa."

37. *Belenois agrippina.*

Pieris agrippina, Felder, Reise der Nov. Lep. ii. p. 173. n. 159 (1865).

♂. "Very local; found at Ambohinamboarna, and seen to the west."

In the Museum we have this species from D'Urban, the forests of Antananarivo, and Abyssinia. I think it doubtful whether it will prove constantly distinct from *B. lordaca* of Walker, to which it is extremely closely allied; from *B.*

mesentina, with which M. Boisduval confounded it, it is very easily separated.

Papilioninæ, Bates.

Papilio, Linnæus.

38. *Papilio demoleus.*

Papilio demoleus, Linnæus, Mus. Lud. Ulr. p. 214 (1764).

"Very common, feeding on the orange-trees. Caterpillar of a lovely green. Fianarantsoa."

39. *Papilio meriones.*

Papilio meriones, Felder, Reise der Nov. Lep. i. p. 93. n. 73 (1865); Trimen, Trans. Linn. Soc. xxvi. pl. 42. fig. 1 (1869).

♂ ♀. "Found in the Tanala; uncommon at Fianarantsoa."

40. *Papilio Delalandii.*

Papilio De Lalande, Godart, Mém. Soc. Linn. Paris, ii. pl. i. figs. 1, 2 (1823?).
Papilio Delalandii, Lucas, Lep. Exot. pl. 20. fig. 2 (1835).

♀. "Found only in the forest. Fianarantsoa."

41. *Papilio epiphorbas.*

Papilio epiphorbas, Boisduval, Faun. Madag. p. 13. n. 3, pl. 1. fig. 1 (1833).

"Common near the forest. Fianarantsoa."

These common species are seldom brought to England in any numbers; of this black-and-green *Papilio* we have hitherto only had a single example.

Heterocera.

Sphingidæ.

Chœrocampinæ, Butler.

Chœrocampa, Duponchel.

42. *Chœrocampa osiris.*

Deilephila osiris, Dalman, Anal. Entom. p. 48. n. 21 (1823); Boisduval, Icon. Hist. Lép. p. 18, pl. 49. fig. 1 (1832).

"Feeds on the vine plant." Fianarantsoa.

Acherontiinæ, Butler.

Acherontia, Hübner.

43. *Acherontia atropos.*

Sphinx atropos, Linnæus, Mus. Lud. Ulr. p. 348. n. 8 (1764).

"Caught in the forest, and only seen there." Fianarantsoa.

The European death's-head moth occurs also in Mauritius and Rodriguez.

Sphinginæ, Butler.

Nephele, Hübner.

44. *Nephele Densoi.*

Zonilia Densoi, Keferstein, Entom. Notiz. p. 14, fig. 5 (1870).

Fianarantsoa.

Zygænidæ.

Pseudonaclia, Butler.

45. *Pseudonaclia sylvicolens*, n. sp.

Primaries chocolate-brown; a subtriangular basal spot, a large central transverse subovate spot, and two smaller discal spots (one below the other) pale stramineous or yellowish white and semitransparent: secondaries ochreous, with chocolate-brown outer border: antennæ black and broadly pectinate; thorax black; shoulders and abdomen ochreous. Body below ochreous. Expanse of wings 1 inch 2 lines.

"Found in the forest. Fianarantsoa."

The primaries of this species are unusually long and ample.

Nyctemeridæ.

Hylemera, n. gen.

Allied to *Secusio*, but the primaries shorter and broader and with entirely different neuration; costal vein united to the first subcostal branch, which is forked, by a short oblique veinlet; second subcostal branch emitted just beyond the first and trifurcate, the first furcation being emitted from below the nervule, and the other two forming a fork to apex; radials emitted near together from the end of the cell; three median branches emitted normally: secondaries with the costal vein running from the base, but touching the subcostal near the base; first and second subcostal branches emitted from the end of the cell instead of from a footstalk. Type *H. tenuis*.

46. *Hylemera tenuis*, n. sp.

White, semitransparent: primaries ochreous at the base; basal two fifths limited by a dusky line, which terminates upon the costa in a large black spot; a small black spot at the end of the cell; apex and outer border broadly black: secondaries with a small blackish spot at the end of the cell: antennæ and thorax black; head, collar, and tegulæ ochreous; abdomen white; legs sordid white. Expanse of wings 1 inch 3 lines.

"Found in the forest. Fianarantsoa."

Liparidæ.

Dasychira, Stephens.

47. *Dasychira mascarena*, n. sp.

♂. Primaries dull green, crossed near the base by two interrupted white-bordered black lines followed by two widely separated irregular dentate-sinuate white-bordered black lines; a sinuous discal series of white-bordered black spots and a regular submarginal series; fringe whity brown, spotted with black: secondaries pale greyish brown, with whitish costal area: thorax whitish, abdomen brown. Under surface whitish, without markings. Expanse of wings 1 inch 11 lines.

♀. Altogether whiter than the male, the borders of the black markings being broader, the secondaries white with the exception of a cuneiform submedian patch, and the body white. Expanse of wings 2 inches 2 lines.

"♂ ♀. Common about Fianarantsoa. Caterpillar has tufts of black bristles. In cocoon 21 days."

This species seems to be nearly allied to *Desmeocræra nugatrix* of Felder; but (besides the *specific* difference of straight and continuous black lines across the primaries) the artist has represented *D. nugatrix* with a filiform termination to its antennæ, such as exists in no true *Dasychira*, but which may appear to exist if the antennæ are looked at from above.

Saturniidæ.

Caligula, Moore.

48. *Caligula suraka.*

Saturnia suraka, Boisduval, Faun. Madag. pl. 12. fig. 4 (1833).

♂ ♀. In bad condition. Fianarantsoa.

I have never yet seen a really good specimen of this magnificent silk-moth; yet it seems to be not uncommon in Madagascar.

Lasiocampidæ.

Borocera, Boisduval.

49. *Borocera madagascariensis.*

Borocera madagascariensis, Boisduval, Faun. Madag. pl. 12. figs. 5, 6 (1833).

♂. Fianarantsoa.

"Called 'Land-amboa.'"

This species is so poorly figured in the "Faune de Madagascar" that it is by no means surprising to find a second species of the same genus described by Mr. Walker under the name of *Gonometa postica*, and separated from *B. madagascariensis* by 495 pages.

Hadenidæ.

Dianthœcia, Boisduval.

50. *Dianthœcia graminicolens*, n. sp.

Very near to "*Hadena* (?)" *leucosoma* of Felder; but the primaries dark shining cupreous brown with white-edged greyish-brown markings, the submarginal white dots replaced by an interrupted zigzag white line, which borders the inner edges of the black triangular marginal spots: secondaries also of a slightly brownish rather than greyish tint. Expanse of wings 1 inch 4 lines.

"Found amongst grass. Fianarantsoa."

But for the submarginal white dots in Felder's figure and the absence of the submarginal zigzag line, I should have taken it for an undercoloured representation of this species.

Catephiidæ.

Audea, Walker.

51. *Audea ochreipennis*, n. sp.

Primaries ashy grey, the internal area and apex clouded with brown; an abbreviated zigzag black litura at the base, followed at a short distance by a zigzag black line which crosses the wing; a slightly curved and irregular transverse central dusky line; two parallel zigzag blackish lines just beyond the middle, the outer one very indistinct and followed by a series of hastate white spots, two of which (near the apex) are externally edged with black; a nearly marginal series of elongated black dots: secondaries clear ochreous; upper half of discoidal cell pearly; a quadrate blackish patch at the centre of external border; thorax ashy grey, clouded with brown: abdomen ochreous, with dusky anal tuft; tarsi brown, banded with white. Under surface pale creamy ochraceous: primaries with the external half dusky, crossed externally by a broad whitish belt; apex pale: secondaries with the quadrate blackish patch on the border as above. Expanse of wing 2 inches.

Fianarantsoa.

"The caterpillar of this is so like the bark of the tree as to be almost indistinguishable."

Ommatophoridæ.

PATULA, Guénée.

52. *Patula Walkeri.*

Patula Walkeri, Butler, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. p. 406 (1875).

"Not uncommon; often found in houses and caves."

CYLIGRAMMA, Boisduval.

53. *Cyligramma duplex.*

Cyligramma duplex, Guénée, Noct. iii. p. 187. n. 1579, pl. 20. fig. 2 (1852).

"Found in nearly all the caves; many may be found dead, covered with white fungus."

C. raboudou of Lucas seems to be allied to this species.

54. *Cyligramma disturbans.*

Nyctipao disturbans, Walker, Lep. Het. xiv. p. 1307 (1857).

"Common in shady woods. Fianarantsoa."

This is the second specimen that I have seen of *C. disturbans.*

Botydidæ.

BOTYS, Latreille.

55. *Botys phyllophila*, n. sp.

Bright clear straw-yellow, with an undulated disco-submarginal reddish stripe spotted with pearly whitish; cells terminating in spots of the same colour: primaries with two short reddish stripes across the basal area; a reddish oblique rectangular crank-shaped stripe just beyond the middle; a pearly-centred reddish spot within (as well as at the end of) the cell: secondaries with a zigzag reddish stripe beyond the middle: palpi red-brown above, white below; head and thorax yellow, centre of prothorax reddish; abdomen brownish (perhaps discoloured). Under surface altogether paler, without markings. Expanse of wings 1 inch 5 lines.

"This was brought in amongst leaves, which it had bound closely by its cocoon-silk." Fianarantsoa.

Nearly allied to *B. caldusalis* of India.

SCOPULA, Schranck.

56. *Scopula*, n. sp.

Near to *S. martialis*, but much larger; it is too much rubbed for description.

XXXIV.—*On the Syringosphæridæ, an Order of Extinct Rhizopoda.* By Prof. P. MARTIN DUNCAN, M.B. (Lond.), F.R.S., &c.

THE late Dr. Ferd. Stoliczka collected some very remarkable spheroidal fossils in the Karakorum range of mountains, in strata beneath the Lias, and of an age which may be Rhætic or Triassic. His lamented death prevented his describing these so-called "Karakorum stones;" and Mr. W. T. Blanford, F.R.S., forwarded me the specimens, with a request from Mr. Medlicott, F.R.S., Director of the Geological Survey of India, that I should describe them for the forthcoming volume on the "Mission to Yarkand." Having carefully investigated the nature of these remarkable forms, I can come to no other conclusion, than that they will not fall within any known order in our classification, and that two genera must be founded to receive them.

As the description of the forms, illustrated by drawings, is to be published, it is only necessary to give an abstract at the present time. But, first of all, it must be noticed that these large spherical and spheroidal stones are not quite new to science. In 1867 Dr. Vauchère, in a paper on the geology of Kashmir, mentions them, and describes some as *Sphæronites*, giving very bad drawings of the outside only.

In the museum of the Geological Society there is a specimen derived from Kashmir, and presented by Captain (now Col.) Godwin-Austen in 1864. It bears the title *Sphæro-*

spongia?; and Prof. Rupert Jones, F.R.S., marked it years ago with *Parkeria*? It has the shape of one of that last group, and the external mamilliform ornamentation also. Stoliczka felt disposed to place the fossils amongst the Corals.

Having had careful radial and tangential slices taken from four differently ornamented specimens, and having examined the eleven very fine forms, I find that they are not Crinoids, Corals, Sponges, or Foraminifera.

The fossils are calcareous; they present no trace of having been attached during life; they are nearly spherical and symmetrical, and, in some instances, more or less oblately spheroidal. They are from one to three inches in their greatest diameters; and their state of preservation is wonderfully perfect. On the surface are more or less rounded or verruciform elevations, and sometimes limited depressions resembling large pores; and these may be on or between the elevations, or generally distributed.

The whole surface is composed of a close reticulation of minute tubes, of the openings of tubes on the surface, and of interspaces between the tubes. Within, the fossils consist of congeries of tubes $\frac{1}{300}$ to $\frac{1}{1000}$ inch, in limited radial groups, separated by an interradial structure composed of a reticulation of inosculating tubes, of which some of the tubes on the surface are the representatives.

The tubes in the radial series, form very numerous cones, the apex being central and the base on the surface of the fossil, usually, but not invariably, corresponding with an eminence. The interradial tubes may be close or wide apart; and they are derived from the radial sets by lateral branching. The walls of the tubes are composed of opaque, granular, irregular, semi-spiculate-looking, and very minute particles of carbonate of lime; there are no diaphragms. There is no intertubular structure or skeleton or cœnenchyma. The spaces between the tubes are filled with calcite; and the same mineral is in the tubes.

The course of the radial tubes is sometimes straight, and they bifurcate over and over again; but usually they bend suddenly repeatedly and then pursue a straight course. The pores have a tube or tubes around their margin, and some openings of tubes on their floor; they are not always present; and sometimes they relate to the radial and at others to the interradial sets of tubes. They appear to be conditions of growth.

The genus *Syringosphæra* has eminences and pores on its surface, and the radial and interradial systems of tubes, and no intermediate skeleton or labyrinthic system. Probably there are four or five species of this genus. The second genus, *Stoliczkaria*, is without pores or has them microscopically developed, the internal tubulation being remarkably close; it contains two species.

The sections of these spheres present microscopical appearances second to none in their beauty; and the polarizing apparatus enables cleavage- and other lines of a non-organic nature to be distinguished. I must apologize for this brief notice; but as the details are about to be published by the Indian Government, I am not at liberty to anticipate too much.

Sept. 5, 1878.

XXXV.—*Remarks upon the Thalassinidea and Astacidea of the Pacific Coast of North America, with Description of a new Species.* By W. N. Lockington.

Thalassinidea.

Family **Gebidæ.**

Gebia pugettensis, Dana.

Gebia pugettensis, Dana, U.S. Ex. Exp., Crust. i. 510, pl. xxxii. fig. 1; Stimpson, Crust. & Echin. P. S. N. Am. p. 48.

This species is exceedingly abundant in San Francisco and Tomales Bays, and frequently attains a length of six inches or even more.

The subterranean passages made by it are usually nearly perpendicular, about an inch across, and very neatly rounded in section, with the walls smooth as if plastered, the smoothness resulting entirely from the pressure of the animal's body as it pushes itself upwards and downwards by the action of its terminal abdominal segments.

The burrows are not confined to strata of sand, but are abundant also in mud, in sandy shingle, and even among rocks, ranging upwards almost to high-water mark, and downwards to at least three or four fathoms, since large specimens were brought up in abundance by the dredging-machines in Oakland Harbour.

Almost every specimen collected in Tomales Bay, in the month of May, bore upon its abdominal feet either the curious Isopod *Phyllodurus abdominalis* (Stimpson, *op. cit.* p. 71), or a small bivalve mollusk, *Pythina rugifera*, Carpenter.

While most of the smaller individuals are accompanied by a pair of *P. abdominalis*, the larger specimens were free from this crustacean, but in many cases bore the mollusk above mentioned.

In only one case, out of over a hundred specimens dug up in Tomales Bay, were the mollusk and the Isopod found in company upon the same *Gebia*; and in this case the *Gebia* was of middling size, and the mollusk very small. On specimens collected July 4 I did not find the bivalve, and the *Phyllodurus* was less common than in May.

In San-Francisco Bay I have not as yet detected *Pythina rugifera*, but *Phyllodurus* is sufficiently common.

Gebia pugettensis is on record from various points along the Pacific coast from Puget Sound to Monterey, and also from San-Quentin Bay, west coast, Lower California.

Gebia spinigera, S. I. Smith.

Gebia spinigera, S. I. Smith, Report Peabody Acad. Sci. 1869, p. 92.

A large number of specimens, all females, were collected by J. A. M'Neil, at the island of Aseredores, 20 miles northwest of Corinto, Nicaragua; and a few were also collected in the Gulf of Fonseca.

Gebia longipollex, T. H. Streets.

Gebia longipollex, T. H. Streets, Proc. Acad. Nat. Sci. Phil. Dec. 1871, p. 242.

This species, having a tridentate front, and a small spine on the carapax over each antenna, is described in a "Catalogue of Crustacea from the Isthmus of Panama," collected by J. A. M'Neil, and probably came from the Pacific coast of the isthmus.

Gebia rugosa, nov. sp.

Rostrum short, thick, obtuse at tip, curved downwards to the level of the centre line of the cornea of the eye. Upper orbital margin curving outwards convexly; margins of anterior portion of carapax, posterior to the curve, straight, but gradually divaricating. Upper surface of rostrum and carapax, to about halfway to the dorsal suture, beset with small tubercles and hirsute.

Cornea black, visible from above between the rostrum and the outward curve of the carapax.

Antennæ projecting beyond rostrum to a length about equal to that of carapax, sparsely setose.

Antennulæ less than half the length of antennæ, branches of flagella equal, the upper stouter than the lower.

Chelipeds equal; merus compressed, smooth, equal in length to the hand; carpus smooth, about half the length of upper margin of propodus; propodus smooth, sparsely hirsute, the hairs most abundant on inner side; pollex short, sharp-pointed, curved regularly upwards; dactylus less than half the length of palmar portion of hand, which is thickly hirsute, curved regularly downwards, its tip passing beyond that of the dactylus.

Four hinder pairs of pereiopodi compressed, the posterior margins and tips of the propodi hirsute, also, to a less extent, the posterior margins of the carpi.

Anterior margin of the merus and propodus of the second pair set with long hairs.

Posterior margin of fourth abdominal segment beset with short stiff hairs; the three posterior segments and the lateral caudal appendages complexly wrinkled above, the rugæ smooth. Terminal segment broader than long, distal margin longer than proximal; caudal processes large, filling up the space between the terminal and fifth segments.

Length of larger specimen 25 millims.

Two specimens of this species were collected at Port Escondido, Gulf of California, under stones and coral at low tide, August 1876.

Callianassa californiensis, Dana.

Callianassa californiensis, Dana, Proc. Acad. Nat. Sci. Phil. 1854, vii. p. 175; Stimpson, Crust. & Echin. P. S. N. Am. p. 49, pl. xxi. fig. 4.

Stimpson records the occurrence of this species at Fort Steilacoom, Puget Sound (*Suckley*), and near the mouth of San-Francisco Bay (*Trask*). I have not been fortunate enough to meet with it in the latter locality, but have found it in abundance near Preston's Point, Tomales Bay.

In the museum of the Cal. Acad. Sci. are several specimens from Mutiny Bay, Alaska.

Both the anterior feet of the female are of a bright rose colour; but the large hand of the male is nearly of the same tint with the body.

Upon specimens I collected in Tomales Bay were numerous minute red parasites which I neglected to examine, but conjecture to have been Acarida.

Callianassa gigas, Dana.

Callianassa gigas, Dana, U.S. Ex. Exp., Crust. i. 212, pl. xxxii. fig. 3: Stimpson, Crust. & Echin. P. S. N. A. p. 49.

I have not met with this species in the vicinity of San Francisco; nor does it occur among the numerous species of Crustacea, including two new Thalassinidea, collected by Fisher on the coasts of the Gulf of California.

Dana met with it in Puget Sound.

Callianassa longimana, Stimpson.

Callianassa longimana, Stimpson, *op. cit.* p. 50, pl. xxi. fig. 5.

This species, originally collected at Fort Steilacoom, Puget Sound, by Dr. Suckley, occurs also at Santa-Rosa Island, one of the Santa-Barbara group, at San Diego, and at San-Quentin Bay, Lower California. Doubtless it occurs at points intermediate between these widely separated localities.

Callianidea typa, M.-Edwards.

Callianidea typa, M.-Edwards, Hist. Nat. des Crust. pl. xxv. *bis*, figs. 8–14.

It was with some surprise that I found, among other specimens of Crustacea collected by Mr. W. J. Fisher in the Gulf of California, some examples of this species, first collected by Messrs. Quoy and Gaimard upon the coasts of New Ireland. After careful examination I cannot detect any difference between my specimens and the figures given by Milne-Edwards, although the localities are so wide apart.

The specimens, three in number, were taken at La Paz at low tide.

Total length of second largest specimen 50 millims.; length of smaller hand 10, of larger 15. Length of manus of larger cheliped of largest specimen 24 millims., of palmar portion 14, of carpus 3, of merus 11; of manus of smaller cheliped 15, of carpus 8·5, of merus 8·5; width of manus of larger cheliped 10.

Astacidea.

Panulirus interruptus, Randall.

This is the "lobster" of the San-Francisco market. Large numbers are caught at Santa Barbara and other points south of San Francisco.

Stimpson states that it inhabits rocky ledges in rather deep water.

Panulirus guttatus, Gray.

Dr. T. Hale Streets mentions this species among those collected by J. A. M'Neil upon the Isthmus of Panama, presumably from the Pacific coast.

Panulirus americanus, Lamarck.

Also included in the above-mentioned catalogue.

Panulirus gracilis, Streets.

Panulirus gracilis, Streets, Proc. Acad. Nat. Sci. Phil. 1871, 225, pl. xi. fig. 2.

This form is described by Streets from a specimen 0·9 inch in length, probably a very young individual.

Astacus Gambelii, Agassiz.

This very distinct species appears to be peculiar to the central region of North America; all the specimens I have seen have been collected east of the Sierra Nevada.

It is easily distinguished from the species inhabiting the rivers flowing into the Pacific, by the pilose areas upon the upper surface of the chelæ, and by the simple rostrum.

Astacus nigrescens, Stimpson.

Astacus nigrescens, Stimpson, Crust. & Echin. P. S. N. A. p. 52.

This species appears to be found in most of the larger brooks of the central counties of California, such as the Alameda Creek, Alameda Co., Coyote Creek, Santa-Clara Co., and San-Joaquin Slough.

It is occasionally sold in the markets of San Francisco. Adult specimens exceed 4 inches in length.

Astacus klamathensis, Stimpson.

Astacus klamathensis, Stimpson, *op. cit.* 54.

This small species, first found in Klamath Lake by Dr. Newberry, has also been taken in the Columbia River; and I have collected several individuals in Eel River, Humboldt Co., California.

Astacus Trowbridgii, Stimpson.

Astacus Trowbridgii, Stimpson, *op. cit.* 53.

The terminal spine of the rostrum is less slender than in *A. nigrescens*; and a single prominent antero-lateral tooth on each side supersedes the five or six small sharp spines of that species. The edges of the terminal spine are serrated.

Astacus læviusculus, Dana.

Columbia River, Puget Sound.

San Francisco, Aug. 28, 1878.

XXXVI.—*On the probable Nature of the Animal which produced the* Stromatoporidæ, *traced through* Hydractinia, Millepora alcicornis, *and* Caunopora, *to* Stromatopora. By H. J. Carter, F.R.S. &c.

As there are undoubtedly several species of *Stromatopora*, and each species may have several varieties, while the whole may be variously altered by mineralization, these contingencies are too numerous for me to undertake the palæontology of the whole group, and therefore I shall confine myself solely to the probable nature of the animal which produced them.

I need hardly premise that in proportion to the knowledge of beings actually living will be that of those which have passed away—that is, that it is impossible to be a good palæontologist without being a good morphologist, either specially or generally, and therefore that a knowledge of geology alone cannot make a good palæontologist.

Take, for instance, the following fact, which no amount of fossil material could afford, and which nothing but a knowledge of recent structure could supply, and the foregoing premise becomes evident.

Thus, the embryo of *Hydractinia echinata* begins its structure, both soft and hard, by developing a sarcodic membrane which is traversed by a vascularity consisting of *rami*, *ramusculi*, *ramuscunculi*, &c., *over* which minute points of chitinous or horny matter subsequently appear along the course of the vessels (that is, outside their walls), which, after having grown into branched elements, ultimately become incorporated in the formation of the fibre of the polypary or cœnenchyma, after the manner of *Millepora alcicornis*, as will be more particularly explained by-and-by ('Annals,' 1873, vol. xi., and 1877, vol. xix.). When the soft parts are abstracted the *spaces* alone which they occupied are left, whereby the cœnenchyma becomes, as it were, the *mould* of the vessels. *Pari passu* with the development of the cœnenchyma is that of the polypites and the development of new vascular *foci*, from which it happens that the ultimate radicles of the branches of the different *foci* unite with each other, and thus the structure is extended.

This, which may be termed the "proliferous membrane," hydrophyton of Allman, or cœnosarc, may be assumed to have existed in all Hydrozoic cœnenchymata of the kind, whether present or past; and thus our knowledge of the recent structure will be found to afford us decisive explanation of that which might otherwise have remained conjectural for an unlimited period.

Passing on to *Millepora alcicornis*, which is a Hydrozoic coral, we find precisely the same kind of grooved venation, indicative of the previous existence of a "proliferous membrane," as in *Hydractinia echinata*, only that, for the most part, it is concealed by the surface-layer, which requires to be picked off with a sharp-pointed instrument to bring the venation into view. (Scraping off the layer with a sharp knife will also do this, but not so satisfactorily, especially as by the former method portions of the dried vessels themselves often remain *in situ*.) Yet occasionally the grooved venation appears in the surface, as may be seen on a specimen at the British Museum in one of the upright cases in the coral-room, labelled accordingly. (This specimen is composed of cylindrical anastomosing branches beset with short, stout, spine-like processes, altogether presenting a flat clathrous mass about twelve inches broad and nine inches high as it now stands.) There is also another specimen, more like the typical *Millepora alcicornis* in shape, from the flatness of its branches, whereon the grooved venation is partial—that is, obvious outside in some parts only. This venation was seen by Mr. H. N. Moseley "on the surface of a corallum in a species of *Millepora* obtained at Zamboangan, Philippines" (Phil. Trans. 1877, vol. clxvii. p. 125); and a similar reticulation may be observed with a common lens *in* the horizontal lamina of *Tubipora musica*, as it appears through the upper layer.

In a vertical fracture of a branch of *Millepora alcicornis*, holes here and there, indicative of the larger branches of the grooved venation, may be seen just under the surface-layer, while the smaller ones which rise into it are lost by becoming continuous with the vermicular interspaces of the cœnenchyma; except in some instances, where the vessels which occupy them appear to have become calcified and thus rendered visible by a slight portion of the surface-layer being shaven off with a very sharp knife. Indeed the same condition sometimes leads to their permanency on the *outside* of the surface-layer, where they may be seen with the naked eye, or at least with a lens of moderate power. At the same time, in this state they must not be confounded with that common calcareous white mycelium which, either Foraminiferous or Saprolegnious, pervades almost every marine calcareous structure.

That, however, the vessels of the "proliferous membrane" are sometimes calcified is worth remembering, as it may hereafter explain how, in the fossil species, they appear sometimes as *mere spaces*, whereby they may often be easily overlooked, and at others in the form of *calcified canals*.

The vascularity of the "proliferous membrane," which has been examined by Mr. Moseley in the recent state, and identified with the "hydrophyton" of Allman (cœnosarc auct.), is beautifully represented in his figures 12 and 16, plate iii. (*op. et loc. cit.*), where the vessels are shown to be surrounded and filled respectively with ectodermic and endodermic cells of different kinds which produce the various elements of which the Millepore is composed.

Having thus pointed out the source from which the corallum of *Millepora alcicornis* is derived, I have now briefly to allude to the composition of its ultimate structure; and for this purpose let us assume that a branch has been broken off from the main specimen, and that we are examining the vertical fracture (for this is preferable to any other method, as involving the least destruction of the more delicate parts). We may observe that the branch is marked by an axial, a middle, and a superficial structure, all three of which are differentiated by the following peculiarities. The "axial structure" is here represented by a number of minute holes in juxtaposition (that is, a cribriform cœnenchyma), in which the surface of the hard parts towards the holes or spaces is more compact than the rest; that is, the surface is more opaque and whiter than the interior, which, on the other hand, is composed of more transparent calcite. This, again, which will be generally found to be the case with the cœnenchyma, is worth remembering, because it will lead to the explanation of a similar appearance in the elements of the fossil structure, which otherwise might be set down as originally hollow or filled with cœnosarc. The "middle structure," on the other hand, is more compact, and its cœnenchyma composed of a *curvilinear* element or fibre, moulded over a vermiculo-reticulate cœnosarc, whose tortuous anastomosing canals alone remain in the dried corallum, more or less obliterated *here* by thickening. This basic structure, again, is traversed by tubular *spaces* at variable distances from each other, which radiate from the "axial structure" towards the circumference of the branch ('Annals,' 1878, vol. i. pl. xvii. fig. 5), where they end in the calicles respectively, and, besides being in direct communication with the vermicular spaces of the *curvilinear* cœnenchyma, which open into them all round, are more or less divided *transversely* into compartments by calcareous septa (often surmounted by a stylous process), which have been called "tabulæ," each compartment indicating the successive development of a polypite or hydranth; hence the term "tabulated" has been applied to them. (This is a common feature of the tubes of *Heliolites*, *Halysites*, and *Favosites*.) Lastly, the "superficial structure," which is the surface-layer, is formed exactly like the "middle structure," only that, being actually under growth, it is less compact, whereby the transverse sections of the larger branches of the "proliferous membrane," or hydrophyton, are rendered more visible between it and the outer margin of the "middle structure" than in the layers of the latter.

Turning now to an examination of the branch *longitudinally*, we may reverse the order of the description; and taking the "superficial structure" first, we observe the same curvilinear character of the elementary composition of the cœnenchyma as before mentioned, but more open and, where definitively formed, presenting, sometimes on the surface and generally in the deeper parts, a convoluted appearance of the typical curvilinear character, in miniature like the convolutions of the brain, united by transverse processes or bars—in short, very much like the remains of a thoroughly worm-eaten piece of wood,—but where imperfectly formed, as on the surface chiefly, more or less spined, owing to its being formed in the first place of small, nodose, bacillar, and branched (?) calcareous spicules, which, before they become entirely incorporated into fibre, project more or less beyond the surface of the latter (accounting, perhaps, for the granular and cribriform appearance of the fibre in *Caunopora* &c., that will hereafter be mentioned), subsequently passing into the typical *curvilinear* form, and finally, more internally (that is, in the "middle structure"), into a solid crystalline state with radiated structure, like that represented by Mr. Moseley (*op. et loc. cit.* pl. 2. fig. 8), in which no trace of the original spicular element remains, as in *Tubipora musica*—a transition first mentioned by Ellis in the red coral (*Corallium rubrum*), who states that he received the "hint" from Dr. Donati (Ellis and Solander, 'Nat. Hist. of Zoophytes,' 1786, p. 78).

This can be well seen in *Millepora alcicornis* with an inch-focus compound power, magnifying about 100 diameters, probably better in the living than in the dried specimen, where, unless protected by the overgrowth of a piece of sponge, as is often the case in specimens from the West Indies, it is generally rubbed off like the corresponding parts in *Tubipora musica.* The process of incorporating the spicular elements into calcareous fibre seems analogous to that which takes place in the vitreous hexactinellid sponges, wherein the mould of the spicule may be brought back by some solvent, viz. an acid in the former and an alkali (as Mr. Sollas has shown) in the latter. In *Corallium rubrum* a transverse section ground down to extreme thinness will well show what was stated by Donati so long ago.

Here and there again, on the surface of the "superficial structure," may be seen the calicular spaces of the full-formed polypite and those of the zooid respectively, more or less irregularly scattered about, more or less thickly, more or less in number, the one or the other, sometimes in groups, as in the species from Tahiti figured by Mr. Moseley, of which I also possess a specimen from the West Indies.

Occasionally, as before stated, the surface of the "superficial structure" presents the grooved venation indicative of the vascularity of the "proliferous membrane;" while for the most part this only becomes visible after the surface-layer has been picked off, as before stated, when it may be seen sunk into the outer layer of the "middle structure."

Splitting now the branch longitudinally, both the "middle" and the "axial structure" are brought into view, when the former, of course, presents the same features as in the transverse fracture; while the "axial," which in the transverse fracture only appears as a cribriform surface, is now found to be composed of *longitudinal* tubes in juxtaposition, more or less interrupted by *tabulæ*, and more or less pierced with holes, by which they communicate with each other.

In most instances also, as before stated, the grooved venation, which represents the larger vessels of the "proliferous membrane" or hydrophyton, is concealed beneath the superficial layer; but as the branch grows by additional layers to its surface, it is evident that this layer must be thin before it can be thick, and that therefore, if the specimen meet with its death or be seen when the surface-layer is thin, the vascularity will be visible to the naked eye, and *vice versâ.* Hence the absence of the grooved venation on the surface in some, but not in all, specimens may receive this explanation both in the recent and in the fossilized structures.

This seems to be the proper place to notice the differences that exist between a coral (Actinozoic or Hydrozoic) and a sponge, which may be thus described, viz.:—

A coral grows from an embryo which develops one animal, the polyp; and this animal has but one opening, through which the food is taken in and the refuse discharged. After this a plurality of polyps are developed from stoloniferous buds around the original one, in the form of a layer supported by their calcareous cœnenchyma, the original polyp developing another polyp *directly over* itself; then other layers of polyps accompanied by their cœnenchyma follow, until the ultimate form of the coral, whether branched or massive, is attained; while as each layer of polyps is formed respectively over its predecessor (increased by *branching*, of course, to fill up the extending circumference) the parts below pass into cœnosarc, which thus, for a time, fills up the interspaces of the cœnenchyma, until, in the massive corals, the cœnosarc itself perishes, and thus the base becomes virtually dead. In *Madrepora abrotanoides* the successive development of the central or original polyps over each other is distinctly shown by a branch which is broken off at each end, when the centre of the cœnenchyma at both extremities presents the septate or mesentericated cell of the polyp, with this difference only, that the structure is thicker or more condensed in the lower or older part. Still the mesentericated tube is continued throughout; and as the corallum of the Hydrozoa is subject to the same repetitionary conditions in development, it is not uncommon to see the same tube, whatever this may have been, continued vertically through the mass in a similar growth of *Stromatopora*, until it appears in the centre of the stelliform hydrophyton on the surface, presenting the same appearance over each successive layer of the coral. To this point I shall have to return by-and-by, merely observing now that what produces the polyp also produces the hydrophyton, and therefore the two may have been combined or separate in the same mass.

A sponge, on the other hand, grows from an embryo which develops a sarcoid surface-membrane pierced with holes (pores) which are ever opening and closing, and interiorly charged with hollow globular groups of mono-flagellated animals, viz. the spongozoa. These, again, receive their food through the pores, and discharge the refuse through the radicles of a branched excretory canal-system, which, becoming larger in proportion to the number of branches it receives, at length terminates in an expanded vent or oscule on the surface. *Pari passu* with this development, a skeletal structure is formed, which, for the most part, is kerato-siliceous or kerato-calcareous; that is, it is composed of chitinous or horny fibre strengthened by siliceous or calcareous spicules. After this, the structure goes on increasing in bulk until the ultimate form of the sponge, whether branched or massive, is attained; but as this increase is only attended with a transformation of the old surface into the internal structure, and the groups of spongozoa go on increasing, while they do not die out in the interior, the excretory canal goes on increasing in size also, until of necessity (that is, from its importance) it becomes the most prominent feature in the structure of the sponge, agreeing in this matter with the excretory canals in all animals, which are largest and most dilated at their outlet —trumpet-shaped.

Hence to have a sponge without a distinct excretory canal-system which, from its preponderance over the other structures, can be seen with the naked eye, would be an impossibility; while the nature of a coral-animal requires nothing of the kind, since it is situated on the *surface* of the mass and discharges the refuse of its food through the same orifice by which it entered the body on the spot.

Having now considered the structure of these recent animals, let us turn our attention to that of the fossilized forms called *Stromatopora*. And here it is desirable to premise that they will be treated of under the family name of Stromatoporidæ, in which the genera *Stromatopora* and *Caunopora* will be included, and the latter described first, as it is partly through *Caunopora* that we shall have to ally *Stromatopora* to *Millepora alcicornis* and thus to *Hydractinia*.

In 1840 (Trans. Geol. Soc. Lond. vol. v. pt. 3) Lonsdale figured and described *Caunopora*, Phill., under the provisional name of *Coscinopora placenta*, observing that "other specimens [of *Caunopora*] might be mistaken for *Stromatopora concentrica*, except that *the tubes* [the italics are mine] with careful search may always be found."

In 1841 Phillips ('Palæozoic Fossils of Cornwall, Devon, and West Somerset') gave the name of "*Caunopora*" to this genus, again with reference to the "tubes;" while Baily, in 1876 ('Characteristic Brit. Fossils'), calls it *Stromatopora placenta*, Lonsdale, previously named by Rosen *Stromatopora Schmidtii* ('Ueber die Natur der Stromatoporen und über die Erhaltung der Hornfaser der Spongien im fossilen Zustande,' Dorpat, 1867, Taf. 4, 5). Finally it has been illustrated by Nicholson and Murie under the name of *Caunopora* (Linn. Soc. Journ., Zool. vol. xiv. p. 219, and pl. ii. fig. 4).

The necessity of making this a distinct genus of the Stromatoporidæ with a different name will hereafter appear evident; and as the latter has already been done, I shall allude to it under the name of *Caunopora* (Phill.) *placenta*, Lonsdale.

My observations on *Caunopora placenta* have been manifold; and up to my last communication on the subject I had always alluded to it under the name of "*Stromatopora*" ('Annals,' 1878, vol. ii. p. 85). This having been explained, then, let us proceed to a description of the fossil dissected out of a calcareous laminated amorphous mass from the Devonian Limestone, about two feet (and probably more originally) in diameter.

Here it is composed of large nodules growing from different nuclei and enveloping during its spreading course more or less foreign material and the petrified remains of many foreign organisms. Taking one of these nodules about three inches in diameter (for they vary in size above and below this measurement), we find it hemispherical or parabolical; and commencing with a horizontal section through the base, the central or axial part is observed to be composed of a cribriform structure, occasioned by the presence of a tubulated cœnenchyma, to be more particularly described presently, of which the ends of the tubes in juxtaposition are alone here visible; outside which, extending to the circumference, is a *curvilinear* cœnenchyma (that is, *curvilinear* in the element, as already described in *Millepora alcicornis*) through which *tubes* at a variable distance from each other radiate from the axial structure to the circumference, intermixed with rods of opaque white calcite taking the same direction, which are intimately connected with the *curvilinear* fibre of the cœnenchyma, of which they, indeed, form part; while they are composed of a more transparent calcite internally, which would lead to the supposition that they were once hollow, did not the same differentiation appear in the cœnenchymal tissue between the tubes in the "axial structure" of the living *Millepora alcicornis*, as before stated. Further, these radiating separated tubes are more or less divided into compartments by *tabulæ*; and here and there, along the lines of concentric laminæ which they traverse, and which characterize the structure generally, are seen circular spaces indicative of vertical sections of horizontal vessels, which we shall presently find, by the indications of the previous existence of stelliform groups of the hydrophyton-vessels on the surface, to have existed between the laminæ respectively.

If we now make a vertical section through the axis of the cone, the same structure will of course present itself externally, while the axial structure, consisting of tubes in juxtaposition radiating upwards and outwards, will come into view *longitudinally*, when they will be found to have been so numerously perforated with holes and traversed by *tabulæ*, that, at first, I was inclined to think this specimen of *Caunopora* had grown upon *Favosites gothlandicus*; nor was I convinced to the contrary until I found a similar differentiation in *Millepora alcicornis*, as already stated, viz. in the "axial structure."

Lastly, if we go to the surface of the nodule or cone, we shall find it to present the same *curvilinear-fibred* cœnenchyma with the separated tubes and rods as above described; but instead of a longitudinal view of them we have here only their ends, in which the former often present a white opacity in the centre as if some of the *tabulæ* had possessed a styloid point similar to that seen on some of the *tabulæ* in *Millepora alcicornis* (at all events there was something of the kind here); while the rods present a transparent centre within the opaque white calcite externally, corresponding to what was seen in the longitudinal section of this part of the cœnenchyma in the horizontal section of the base. But the most remarkable feature of the surface is the presence of more or less stelliform groups of lapidified vessels or spaces irregularly scattered over the laminæ *horizontally*, and therefore repeated after this fashion throughout the mass. The rays of these stelliform groups are more or less dendritic in their form, being branched and subdivided repeatedly, until their ultimate divisions are lost in the vermicular spaces of the cœnenchyma, now equally lapidified, thus becoming continuous with the branches of the neighbouring groups. It is desirable to remember this feature, as we shall hereafter find it to be repeated in *Stromatopora*, sometimes as mere spaces, sometimes as calcified tubes.

In some species of *Caunopora* the *curvilinear* fibre, always more or less granular, appears to be cribriform; but if originally composed of an aggregation of minute spicules, as in *Millepora alcicornis*, this appearance is easily explicable. It is, however, not confined to *Caunopora*; for the *curvilinear* fibre of other coralla (ex gr. *Battersbya inæqualis*) presents the same kind of appearance under similar circumstances—that is, when the plane of section has so passed through it as to show *its interior*; otherwise, as by looking at the fibre *below the surface* of the section, we may observe that the lamina which has enclosed the spicules to form the fibre presents nothing of the kind or merely a granulated exterior.

Thus the presence of spicules in the fibre of *Stellispongia variabilis* ('Annals,' 1878, vol. i. pl. xvii. fig. 10), seen in a microscopic preparation kindly sent me by Dr. G. Steinman, further strengthens me in my opinion that it also was a Hydrozoic coral, at the same time that it points out how easily such fossil structure might be confounded with that of sponges. One should always remember that Nature is ever imitating herself, in general forms especially, and therefore that like forms are not always accompanied by like functions.

What the surface of *Caunopora* was like in its original state I do not know, as all the specimens that I have seen are too weathered to describe this satisfactorily. Perhaps it was like that of *Parkeria*, whose structure elementarily very much resembles that of *Caunopora*; that is, the surface consisted of gentle elevations more or less irregular in their form and diameter. But internally the tubes are often united by cross branches, similar to *Syringopora* in this respect, although widely different otherwise, as the tubes of *Caunopora* are united by the *curvilinear* cœnenchyma, while *Syringopora*, like *Tubipora musica*, had *nothing* between its tubes. Again, a branch of the "stelliform" groups of vessels is often connected with one of these calicular tubes, showing that the calicle and vessels may be combined, and developed from each other, as the case may be.

All this has been witnessed in the Milleporidæ by Mr. Moseley, who states (*op. et loc. cit.*) that "the thin incrusting films of *Millepora*, when dead and dry, show well the ramifications of the canal-systems and their connexion with the calicles" (p. 120), and "in some cases large tertiary branches of the canals join the zooid-cavities directly" (p. 125).

Thus in all essential points the structure of *Caunopora placenta* was the same as that of *Millepora alcicornis*; only the large-branched vascularity of the "proliferous membrane," or hydrophyton, instead of straggling over the surface, was developed from more *foci*, and thus brought into more stelliform shapes. Even in the Stromatoporidæ this differs in degree, as may be seen by comparing Baron Rosen's lithograph of his *Stromatopora elegans* (Taf. iii. fig. 1) with that of *S. Schmidtii* (Taf. iv. fig. 1, *op. cit.*), which, as before stated, was probably a *Caunopora*); while in the specimen of *Stromatopora mammillata*, Nich., from which fig. 10, pl. 1 (Linn. Soc. Journ. *l. c.*) was taken, which came from Canada West, and was shown me by Dr. Murie, *both* the straggling and stellate forms of the vascularity are present on the *same surface*.

We now come to *S. concentrica*, Goldf.; but who has defined this species? Certainly not Goldfuss, either in his diagnosis or in his illustration. Thus, when authors speak of *S. concentrica*, I, after having now studied the Silurian and Devonian species probably as extensively as any one living, whereby a repetition of the same forms in every collection, both English and American, has been witnessed, am thus inclined to think that I have seen specimens of the greater part of the species; yet I am at a loss how to define *S. concentrica*, Goldf., further than Lonsdale has done by stating that it does not present " tubes " like those of his " *Coscinopora placenta*," = our *Caunopora placenta*—which is totally inadequate to our present purpose. There are, however, other features which are common to many forms of *Stromatopora*-structure, which I have never seen in *Caunopora*; and if we combine these with the absence of the " tubes " and a more or less gnarly structure (like that seen in knotty wood) in the section, already represented by Phillips (*op. cit.*) in his figure of *S. concentrica*, we might then get a typical form to which we might still apply the name given to it by Goldfuss, and then know what we were writing about. To these " other features " I shall now allude.

The " gnarly " or undulating character in the general structure of *Stromatopora*, where the bend of the undulation may vary from a few lines to as many inches in diameter more or less, should not be confounded with the *curvilinear fibre* of the cœnenchyma in *Caunopora* already described, nor with the *rectilinear fibre* of *Stromatopora* about to be mentioned. The term " *curvilinear* " has already been explained; and that of " *rectilinear* " means that the lines representing the elementary part or fibre of the cœnenchyma are all more or less straight.

As with *Caunopora*, so with *Stromatopora*; my observations have been manifold; but not having had the opportunity of dissecting a large block of the latter, as with the former, they have been made on fragments of weathered or unpolished and polished specimens respectively, the largest not exceeding nine by four and a half inches in diameter.

Looking at the *vertical* section of *Stromatopora concentrica*, Goldf., as presenting the typical structure of the family, the cœnenchyma may be observed to consist of more or less straight lines arranged horizontally, cut at right angles by vertical ones or rods, which are the thickest of the two; while the *horizontal* section presents a number of white points, which are the ends of the " rods," united together by a *rectilinear* structure consisting of straight lines, which extend between the points and between each other, so as to produce a cribriform lamina with triangular or multiangular spaces. For the term " rectilinear " I have hitherto used that of " hexactinellid," which was evidently a misnomer. Further it should be remembered that in some specimens or species the cœnenchymal structure is extremely fine, and in others, especially the rods, comparatively coarse.

Now, as the *vertical* section shows no trace of the structure seen in the *horizontal* one, saving the margin of the lamina, which is represented by the horizontal lines of the former, and the vertical rods (which are represented by their ends only in the latter), respectively, while, where the plane of the horizontal section passes between two laminæ, the points of the rods *alone* are seen on the immediate *surface*, it becomes evident that the cœnenchyma is formed of vertical rods which support, at variable distances, the horizontal cribriform laminæ.

Again, it is evident that the cœnosarc of this cœnenchyma in *Stromatopora* was as continuous throughout as in that of *Caunopora*, and that the continuity through the cribriform laminæ was kept up in the same way as through the cribriform transverse septa of *Tubipora musica*.

Further, it may be observed that the white or opaque "rods" of calcite, as well as the rectilinear structure of the laminæ generally, present a more or less transparent calcite internally, as in the "axial structure" of *Millepora alcicornis* and in the rods of *Caunopora*, before noticed, whereby, if this had not already been explained, it might seem as if they were originally hollow or filled with some soft fleshy matter.

Lastly, in the horizontal section may be seen, as in *Caunopora*, the stelliform groups of vessels more or less scattered over each lamina, together with more or less transverse sections of them, according to their position, in the vertical section of *Stromatopora*—sometimes in distinct lines where the vessels have calcareous walls, at others as mere spaces in the rectilinear structure, when they may be so indistinct as to escape observation if not sought for carefully; while at other times they may not be present all, as stated in *Millepora alcicornis*, on account of their being concealed underneath the plane of the section, which may have just taken away the upper part of the layer bearing them, and not sufficient of the lower part to expose the following set. Again, in the vertical section there is often indication that a continuous vertical canal, to which I have before alluded, passed up through the whole of the stellate groups in that line, and, thus connecting them together, may have been developed from calicles successively formed on the surface, whereby a continuous canal would be kept up, as in the branch of *Madrepora abrotanoides* before cited; or the canal may be interrupted; or there may be no defined centre or indication of opening there as in *Stromatopora astroites*, Ros. (*op. cit.* Taf. ii. fig. 7); or there may be no stellate centre and the form may be merely dendritic, as in *S. Schmidtii*, Ros. (*ib.* Taf. iv. fig. 1), finally passing into the straggling form observed in *Millepora alcicornis*. Further, the branches of the stellate group may not be horizontal, but sloping all round, as when it is successively developed on the summit of a mamillary process, *e.g.* in *Stromatopora polymorpha*. This is perhaps best seen in the vertical section, where according to the height of the elevation will be the slope of the vessels. But whatever form this vascularity may present, it cannot alter the function, which, as before stated, is that of the "proliferous membrane" or hydrophyton.

We now come to the calicles of *Stromatopora*; and as these are the last indications of the animal which formed it, and we have no "tubes" to aid us here as in *Caunopora*, it will be necessary to give close attention to this part of the subject if the chief object of this communication is to be realized.

I would here premise that, after Dr. Murie had, with his usual desire to sacrifice every thing to truth, however and by whomsoever elicited, shown me Prof. Nicholson's American specimens of *Stromatopora*, which being as they were found (that is, presenting their natural surfaces much better than might have previously been expected after the contingencies to which they must have been exposed for so many ages since they formed the cœnenchyma of living animals), my general impression was that these surfaces were more nearly allied to *Hydractinia echinata* than to *Millepora alcicornis*; and this I find to be confirmed by Prof. Nicholson's following description of his *Stromatopora granulata* (Ann. 1873, xii. p. 94), viz.:—"It forms thin crusts, often occupying very extensive surfaces (3×2 ft. $\times \frac{1}{2}$ in.). Composed of concentric laminæ, about ten in the space of a line, separated by interspaces which are minutely broken up into cells by numerous delicate vertical rods. Surface regularly undulating, often raised into chimney-like or conical elevations, which, however, are never perforated. The entire surface is covered with a fine miliary granulation." To which is added (Ann. 1874, vol. xiii. p. 10), "the pores consist of minute close-set perforations in a delicate calcareous membrane or surface-layer."

I examined several specimens of this species, viz. *S. granulata*, collected by Prof. Nicholson, at Dr. Murie's, and observed that the "conical elevations" were essentially like those of *Hydractinia echinata*; while in one specimen, where a part of the superficial layer had been taken off, and the vessels of the *Stromatopora* thus exposed, the latter presented the usual stellate appearance instead of the straggling form in *Hydractinia echinata* and *H. arborescens* (Ann. 1878, vol. i. p. 298, pl. xvii. fig. 1).

Again, Baron Rosen's representations of *S. Ungerni* (Taf. ix. figs. 5 & 6) and *S. dentata* (Taf. x. figs. 1 & 3), which were similar forms to *S. granulata*, Nich., are, in the matter of the conical elevations on the surface still remaining on the layers internally where the latter have been separated or are surmounted by hollow spaces, almost identical with what I have figured of *Hydractinia echinata*, *H. calcarea*, and the fossil species *H. pliocena* respectively (Ann. 1877, vol. xix. pl. viii. figs. 1, 4, and 9, *c*, *d*).

So that I am quite prepared, under these circumstances, not only *not* to find the "tubes" in *Stromatopora*, as stated by Lonsdale, but to find in their stead indications of the existence of *minute* holes on the surface, as in the *Hydractiniæ*, where they do not exceed the 1-600th of an inch in diameter.

Hall has figured them in his *Stromatopora concentrica*, but unfortunately has not added the measurement ('Palæontology of New York,' 1847, vol. ii. p. 136, pl. 73. figs. 1 *b* and 1 *c*); and I have often seen what I take to be the same foramina, but only in one instance where it seems to admit of no doubt; and this was in a specimen of (to me) *S. concentrica*, which came from the interior of a *Beekite* found near Torbay, and now in the possession of Mr. Vicary, of Exeter, who kindly lent it to me for examination. The transformation of the *Stromatopora* here into silex has been attended by such a definition of structure that the indication of the original holes or calicles which contain the animals is particularly convincing in one part, where they are filled with transparent silex, presenting respectively a white or flocculent centre. They are situated between the points of the "rods" which appear on the surface, are all of the same size, and measure 1-180th inch in diameter, while the white portion in the centre is 1-360th inch in diameter, each of which exceeds in this respect the diameter of the holes of the calicles (that is, the holes which permit the exit of the polypites) in the recent species of *Hydractinia*.

Thus we appear to arrive at the nature of the animal of *Stromatopora*, the signification of the stelliform groups of vessels, and the successive development of the cœnenchyma through *Hydractinia*, *Millepora alcicornis*, and *Caunopora*.

The general form of the Stromatoporidæ would appear to have been indefinite; that is, like reef-corals generally, they grew over every thing with which they came into contact, transforming some things into their own structure, and simply enveloping others, after the manner of *Hydractinia*, progressing by successive lamination; so that, whether *weathering* as in *Caunopora* or as in *Stromatopora*, this was, as in corals, the most prominent feature of the mass,—sometimes thin, spreading, and incrusting (as in *S. granulata*, Nich.), at others more or less massive and erect (as in *Caunopora* and *Stromatopora concentrica*). The most symmetrical specimen of the latter kind that I have seen is in the possession of Mr. Vicary, of Exeter, and came from the Devonian Limestone near Newton Abbot. It is composed of compact black-grey limestone, and in shape is like a large fir-cone, nine inches in diameter longitudinally, five inches in diameter transversely about the centre, and three inches in diameter transversely at the base, which is truncated where it has been broken off from its original attachment. Consisting of layers like the coats of an onion, which, where broken out, show that the cœnenchyma was composed of undulatory laminæ bearing all the typical characters in structure above assigned to *Stromatopora concentrica, but very fine.* Each layer presenting on its surface gentle subcircular elevations or nodules, more or less uniform in diameter, and set together more or less regularly in juxtaposition, but all covered uniformly with a minute miliary granulation, interspersed irregularly with small papillary elevations, after the manner of *Hydractinia*, and each nodule surmounted by a stelliform group of vessels like those of *Stromatopora.* In other specimens, again, these elevations are raised into mammiform processes, as in *S. polymorpha*, Goldf.; and I believe that there are also branched forms, wherein, of course, the stelliform groups of vessels coming from the summits of the mammæ or branches respectively, or in the vertical section of the mass (for this is always sure to occur when, by their lateral growth, they touch each other), cannot present that horizontality which is observed where the layers are more planiform. But as a description of these would lead into the department of palæontology (that is, into specific distinction), I shall only further add that, by reason of the undulatory growth of the surface in the Stromatoporidæ, and the union of the processes thus produced when they come into contact with each other to form the whole mass, a more or less gnarly structure like that of knotted wood is often presented in the interior, which would otherwise be unaccountable.

Of the contributions to our knowledge of the Stromatoporidæ, by far the most valuable that has been published is that of Baron Rosen in 1867, to which I have before alluded, lately brought to my notice through the kind consideration of Prof. Zittel, of Munich. To the text of 98 pages are added, besides woodcuts, 11 lithographic plates, whose figures are preeminent both for accuracy and artistic delineation, illustrating the following ten species, viz.:—*Stromatopora typica*, R.; *S. variolaris*, R.; *S. astroites*, R.; *S. elegans*, R.; *S. Schmidtii*, R.; *S. polymorpha*, Goldf.; *S. mammillata*, F. Schmidt; *S. regularis*, R.; *S. Ungerni*, R.; and *S. dentata*, R.

In the text, by woodcuts and description, Baron Rosen makes the same division in the minute structure of the cœnenchyma as I have done, viz. into "rundlichen Maschen," our curvilinear, and into "dreieckigen Maschen," our rectilinear fibre; but in comparing the Stromatoporidæ with the sponges, he evinces an actual knowledge of the former and only a borrowed one of the latter; while even if he had been right in his identification of the two, it would have been better if this had been based on an *actual* knowledge *of both*.

To one well acquainted with the structure of different kinds of Stromatoporidæ it becomes easy, from what I have before stated of their excellence, to identify the whole of his illustrations. Thus *S. Schmidtii*, Taf. iv. and v., from which he takes the character of his "rundlichen Maschen" (p. 7), is evidently a *Caunopora* which has afforded the character of our "curvilinear fibre," as may be seen from the presence of the vertical spaces or tubes delineated in fig. 2, Taf. v.; while *Stromatopora typica*, Taf. i. and Taf. ii. fig. 1, which has afforded the character of his "dreieckigen Maschen" (pp. 6 & 17), is equivalent in typical structure to what we have assigned to *S. concentrica*—that is, our "rectilinear fibre." *S. elegans*, R., Taf. iii. fig. 1, is evidently the "stag's horn" (vulg.) species of the Devonian Limestone, which, of all that I have seen, presents the most beautiful venation internally. But here again I must stop, as this kind of comparison leads to specific distinction, which I propose leaving to the palæontologist.

With reference, however, to the stelliform groups of vessels called by Rosen "Faserbüschel," and so comparatively overlooked by all preceding and subsequent observers, we find them beautifully delineated, of the natural size, in six specimens out of the ten which he has illustrated; and where they were not seen, as in *S. Ungerni* and *S. dentata*, he suggests (p. 45) that this might have been owing to the "petrifying process." It might, however, have been owing, as before instanced in *S. granulata* (also one of the incrusting species), to their being concealed beneath the superficial layer. Still enough appears, in this admirable "Inaugural Thesis" for his Doctorate, to show that so important a feature in the Stromatoporidæ did not escape the intelligent author's notice, while it strongly recalls to mind the equally admirable "Thesis" of Dr. Ch. Barrois on the "Embryologie de quelques Éponges de la Manche."

Since this paper was written (1st Sept. 1878), I have received from Prof. Nicholson and Dr. Murie a copy of their valuable paper "On the Minute Structure of *Stromatopora* and its Allies" (extracted from the 14th vol. of the Linn. Soc. Journal, Zoology). This welcome contribution to our knowledge of the *Stromatoporæ* enters so fully into every thing connected with the subject that I can hardly do more than refer to that part which bears upon the humble object of my communication.

In the first place, I wish the typical form of *Stromatopora* given at p. 195 had been taken from Mr. Vicary's specimen obtained from the Devonian Limestone near Newton Abbot, instead of from the specimen from the Lower Silurian of Canada " represented in Dr. Dawson's 'Dawn of Life,' as the former is almost perfect, and the latter extremely imperfect and much weathered. (A short description of Mr. Vicary's specimen has already been given.) As for the statement in the *footnote* at the bottom of this page, viz. that I had identified *Stromatopora* with *Caunopora*, what I meant to be understood was that *Caunopora* was the species of *Stromatopora* to which I had all along alluded, and that the so-called "hexactinellid structure" I had found in *S. concentrica*, mihi. I agree *in toto* with the authors at p. 201, where they conclude that the "Stromatoporoids were originally calcareous in their composition," also (at p. 203) that the "radial pillars" (our vertical lines or rods) were "solid," as I have already stated. At p. 209, the "radiated water-canals" are the stelliform groups of canals or branched vessels of our "proliferous membrane," equivalent in part to the hydrophyton of Allman whose contents and surroundings I have shown to have probably been nucleated cells; and, at p. 210, I must consider the "vertical water-canals," where not calicular tubes, to have been the canals of Annelids, with which the *Stromatoporæ* were evidently infested, like *Millepora alcicornis*—which is equally a prey to the boring sponge *Cliona*, whose cavernous excavations, connected by little thread-like canals, often give the coral a lacunose structure. It is with pleasure that I see (p. 217) that the specific descriptions and arrangement are only "provisional," as it affords a prospect of still more valuable information coming from the same source; while I feel convinced that until authors, who can never see *all* the type specimens, have the opportunity of seeing good representations of *all* the well-marked typical species (not like *Stromatopora concentrica*, Goldf. &c.), the nomenclature and arrangement of the Stromatoporidæ will remain in confusion. Thus, as regards the former, we have a *Stromatopora mammillata*, F. Schmidt, of 1858, *apud* Rosen, and a *Stromatopora mammillata*, Nicholson, of 1878, pl. i. fig. 10; again, there are other species figured in Rosen which appear to me, who possess such from the Devonian Limestone, to be figured by Nicholson and Murie under different names, &c., and so on.

I cannot admit any one of the "grounds" (*a–e* inclusive, pp. 228, 229) urged by the authors against my view that *Parkeria* was allied to *Stromatopora*, for reasons already published (Ann. 1877, vol. xix. p. 55 *et seq.*), as well as those given in this paper. The cœnenchyma of *Parkeria* I hold to have been calcareous, and therefore the presence in it of all siliceous material to have been subsidiary or foreign, as in *Stromatopora*, to say nothing of the hosts of microscopic foreign organisms that were enclosed within their structures respectively during growth.

Still the "Flamborough-Chalk Fossils" to which I have alluded (Ann. 1878, vol. i. pp. 413–415), I *now know* not to have been the coralla of Hydrozoa as then suspected, but to have been the skeletal structures of Lithistid sponges respectively, which Prof. Zittel told me he had found at Ahlten, in Hanover, so much better preserved that the spiculation in them was undeniably Lithistid. They had been called by Phillips "*Spongia*" generically, with appropriate specific names, and figured in his 'Geology of Yorkshire.' But by far the most beautiful representations were drawn and lithographed, under the direction of Mr. Ed. Charlesworth, for his London Geol. Journal under the name of *Rhizospongia polymorpha*. These, unfortunately, were never published; but Mr. Charlesworth, in kindly presenting me with a set of them a short time since, added that he had written an account of the fossil Sponges of the Yorkshire Chalk, which might be found in the Proceedings of the Yorkshire Phil. Soc. for 1855 (vol. i. p. 73, pl. 1), with one illustration. In the British Museum these fossils now appear under the generic name of *Eudea*, Römer.

I would also mention here that Prof. Zittel has kindly sent me some calcareous fossils, with microscopic specimens of their structures respectively, showing that they were composed of *fibre* charged with such characteristic triradiate spicules that I must *now* admit that heretofore there have been *calcareous* sponges which have become fossil, although, as Prof. Zittel will probably show in his forthcoming paper on them, they were of a different kind from any now living.

To return, however, to Messrs. Nicholson and Murie's delightful exposition of the Stromatoporidæ, it is pleasant to me, living close to the great focus of Devonian *Stromatoporæ*, to find, in the *footnote* at p. 230, the evidence of an eye-witness that "the Stromatoporoids of the Eifel limestone are in no respect fundamentally different from those of the Devonian of Devonshire and North America."

Lastly, the authors repeat their opinion that, under the circumstances, the Stromatoporidæ should be viewed as "a new section of the Calcareous Sponges, for which" they "propose the name of *Stromatoporoidea*."

But, considering that our conception of a sponge will not allow of our identifying any *other* structure with it, I cannot admit that the animal which produced *Stromatopora*, whatever it may have been, can have been a Spongozoon of the present day or of any other period. If modified, it could not have been a Spongozoon! The minute branches of the vessels of *Stromatopora* inosculate to form the hydrophyton, while the minute branches of the vessels of the excretory canal-system of a Sponge commence in the ampullaceous sac (*Wimperkörbe*).

In the 'Annals' for July this year, Dr. Dawson, F.R.S. &c., shows himself, it is hoped, to be a much better geologist than a palæontologist; for throughout his "careful microscropic studies of *Stromatoporæ*" in 1878, he seems to have been entirely ignorant of what Baron Rosen had done in 1867, or he would surely have somewhere alluded to this remarkable contribution to our knowledge of the Stromatoporidæ.

With such an omission, his failing to find the affinities of *Millepora alcicornis* to *Stromatopora* pointed out by "Mr. Carter" is not surprising to me.

To what "typical *Stromatoporæ*" of Hall, Nicholson, and Winchell, Dr. Dawson alludes when it is implied, from the statement in his 4th paragraph, "that the stelliform or radiating canals do not occur in the common species of *Stromatopora*," I am ignorant; for in all those to which I have alluded as having been brought from America they are present; and Hall's *Stromatopora constellata*, as may be seen from the illustration (*op. cit.* p. 324, pl. 72), seems to have been so named from their presence. It is true that Hall makes this a distinguishing character between his *S. constellata* and *S. concentrica*; but, from what has been above stated, he might have overlooked their representatives in the latter, as it is difficult to conceive how a *Stromatopora* could have been produced without such an organization.

Here, however, I would add that all the specimens of the so-called *Stromatopora concentrica* from the Upper Silurian system which I have had in my own possession and have seen in the museums of London, with the exception of one, have presented the structure of *S. concentrica* above detailed; but this one, which is the *type specimen* from which Lonsdale took his description and delineated his figure in Murchison's 'Silurian System' (1839), does not present the characters of *Stromatopora*, in so far as the surface, although covered with minute granulation, possesses no stelliform groups of vessels and nothing else besides the miliary granulation; while the vertical section, shows an amount of regularity in the laminæ which is seldom seen in the *Stromatoporæ*, together with a form of chamber or interstice square below and arched above, totally different from that of the *Stromatoporæ*, which, on the other hand, is for the most part quadrangular and separated by distinct vertical rods, that may be followed continuously through a plurality of layers. Moreover the vertical section presents none of the transversely cut vessels of the stelliform groups, which are almost always more or less distinguishable in the vertical sections of *Stromatopora*. If this be the "common species of *Stromatopora*" to which Dr. Dawson alludes, then it is possible that he may be right. At the same time it is evidently not a "common species of *Stromatopora*," even if hereafter it should be found to be any species of *Stromatopora* at all. The specimen is now in the British Museum, and was kindly placed before me by Mr. H. Woodward.

After this, Dr. Dawson states that the "corallum of *Millepora*, on the contrary, has no concentric laminæ." How does this accord with the following description by Mr. Moseley of the living species he found at Tahiti, viz. "Layers more or less continuous occur in the more massive coralla, appearing in vertical sections as lines of calcareous matter running parallel to the surface of the corallum, and indicating successive stages of growth" (*op. et l. c.* p. 121)? Besides, the weathered end of any old piece of *Millepora alcicornis*, if cylindrical, will show this. Indeed it is difficult to conceive how it could be otherwise.

The allusion to my not being aware that "the stelliform or radiating canals do not occur in the common species of *Stromatopora*" has been answered; and the hint that my experience in these matters is "limited" is not worthy of a reply.

But when Dr. Dawson adds that it is "difficult to understand" the meaning of my observations on the so-called Eozoon in the paper under reference (Ann. 1878, vol. i. p. 310), I would here observe, by way of explanation, that when the structure of the crystalline stratified rocks called "*Eozoon canadense*" resembles organic remains as much as the play of glauconite in the trap-agates of Western India or any other part, it will be quite time enough to consider whether it is of organic or mineral origin. At present, all that I can state of it, after having examined many typical specimens, besides some in the rough state lately sent to the British Museum from Canada, is that it consists of a laminated structure, and that when it shall be found to present the other structural features of *Stromatopora* (to which *Eozoon* is *now* said to be allied) in addition to this lamination, which is as common in mineral as in organic structure, then, and then only, will I admit its organic origin.

Lastly, when Dr. Dawson offers "mail chippings" for microscopical examination, as if his own opinions had been settled in this way, it puts me in mind of the late Sir Charles Napier in Sind, when I heard and saw him, in his little subaltern's tent, tear off his coat and throw it down in anger, observing to an officer who had come to report his arrival, "There, Sir, did you ever work in your life after this fashion?" meaning in his "shirt-sleeves."

How far the stelliform groups of vessels may always indicate a *Stromatopora* I am not able to state; but they are equally present on the surface of both *Ceriopora venosa*, Goldf. (Taf. xxxi. fig. 2, *a*, *b*), and *Cœnostroma*, Winchell, 1866 (Proc. Amer. Assoc.), as evidenced by the illustration of the former, and specimens of the latter in Prof. Nicholson's American collection, where he does not consider *Cœnostroma* generically different from *Stromatopora* (Nich. and Murie, *op. cit.* p. 210).

XXXVII.—*Studies on Fossil Sponges.*—II. *Lithistidæ.* By Karl Alfred Zittel.

[Continued from p. 247.]

B. *Special part* *.

A. **Rhizomorina.**

Cnemidiastrum, Zittel.

Cnemidium p. p., *Achilleum* p. p., Goldf.
Cnemidium and *Cnemispongia*, Quenst.
Cupulospongia p. p., D'Orb.
Cnemiopelta, Cnemipsechia, Pachypsechia, ? Ceriopelta, and *Trachycinclis*, Pom. (non *Cnemidium*, D'Orb. & Pom.).

Sponge top- or skittle-shaped, cylindrical or cup-shaped, with a depressed central cavity, monozoic, rarely polyzoic. Thick wall traversed by numerous vertical radial fissures (furrows), which frequently fork once or several times exte-

* This portion of Dr. Zittel's memoir has been somewhat abridged. His statement of the sources from which he derived his specimens has been omitted; the species marked with an * are those of which he has examined the original types. He gives the following list of abbreviations employed:—

Court. Ép. foss. = Courtiller, A., "Éponges fossiles des sables du terrain crétacé supérieur des environs de Saumur," Ann. Soc. Linn. de Maine et Loire, 1861, vol. iv.
Etal. Leth. Br. = Etallon et Thurmann, "Lethæa Bruntrutana," Neue Denkschr. schw. naturf. Gesellsch. 1863, Bd. xix. & xx.
From. Intr. = Fromentel, E. de, "Introduction à l'étude des éponges fossiles," Mém. Soc. Linn. Norm. vol. xi. 1859.
Gein. Elbth. = Geinitz, "Das Elbthalgebirg in Sachsen," Paläontogr. Bd. xx.
Goldf. = Goldfuss und Münster, Petrefacta Germaniæ, Bd. i. 1826–1833.

riorly, and then anastomose. Intervening skeletal mass at least twice as wide as the fissures. In unrubbed specimens the radial fissures are seen to consist of vertical rows of canals, the round pore-like apertures of which are quite distinct in the furrows. Within the wall, also, the canals of a row are often separated by a thin layer of skeletal mass; but sometimes they coalesce and form a single fissure-canal traversing the whole height of the wall. When these fissures are filled with rock-mass which offers more resistance to weathering than the skeleton, they project like radiating ridges at the vertex, giving the sponge some resemblance to the calice of a coral.

When well preserved, the outer and inner surfaces of the wall are clothed with a nearly smooth covering-layer, through which the oscula of the radial canals either project as small perforated warts or are simply pierced. Goldfuss figures a specimen of *C. stellatum* with well-preserved oscula, under the name of *C. granulosum* (Taf. xxxv. fig. 7).

The skeletal elements, which are generally converted into calc-spar, are of moderate size, crooked, irregular, branched at the ends, and covered with pointed or blunt spiny excrescences.

The name *Cnemidium*, applied by Goldfuss to this genus, has been given up, although it has been adopted by Quenstedt in South Germany for the cup- and top-shaped sponges with radiate furrows from the Upper Jura. Goldfuss brought together very different things under the name of *Cnemidium*; and although it is evident that *Cnemidium rimulosum* and *stellatum* were specially in mind in the formation of the generic diagnosis, the first species (*C. lamellosum*) belongs to the hexactinellid genus *Pachyteichisma*. Quenstedt in 1843 (Flötzgeb. p. 424) limited the name *Cnemidium* to the forms

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Mich. Ic. = Michelin, H., Iconographie Zoophytologique. Paris, 1840–47.
Pom. Pal. = Pomel, A., Paléontologie ou description des animaux fossiles de la province d'Oran: Zoophytes. Oran, 1872.
Quenst. Handb. = Quenstedt, F. A., Handbuch der Petrefactenkunde, 2te Aufl. 1867.
Quenst. Jura = Quenstedt, F. A., Der Jura. Tübingen, 1858.
Quenst. Petr. = Quenstedt, F. A., Petrefactenkunde Deutschlands, Bd. v. Korallen. Leipzig, 1877–78.
Reuss, Kr. = Reuss, A. E., Die Versteinerungen der böhmischen Kreideformation. Stuttgart, 1845.
Röm. Kr. = Römer, F. A., Die Versteinerungen der norddeutschen Kreideformation. Hannover, 1841.
Röm. Spong. = Römer, F. A., "Die Spongitarien des norddeutschen Kreidegebirges," Paläontogr. xiii. 1864.
Röm. Sad. = Römer, Ferd., Die fossile Fauna der silurischen Diluvial-Geschiebe von Sadewitz. Breslau, 1861.

with the habit of *C. stellatum*, *rimulosum*, &c.; but unfortunately the French authors (D'Orbigny, Fromentel, Pomel) preferred to regard *C. lamellosum* as the type of the genus. The name has since been applied to the most various calcareous and siliceous sponges; and its suppression seems to be the only certain way to avoid confusion.

In Quenstedt's latest work (Petref. vol. v.) there are, on plates 126, 127, and 128, numerous very accurate figures of Upper-Jurassic forms, generally much rubbed, which admirably illustrate the external appearance and the canal-system. Goldfuss's species, especially *C. stellatum*, are rather arbitrarily treated by Quenstedt.

Geological distribution. In the Jurassic formation.

Species:—

1. *Cnemidium stellatum*, Goldf. iv. 2 † (non xxx. 3).
   Cnemidium granulosum, Münst. Goldf. xxxv. 7.
   Cnemispongia Goldfussi, Quenst. Petr. cxxvi. 73, 74, cxxvii. 1–16.

2. *Cnemidium striato-punctatum*, Goldf. vi. 3.
   Cnemispongia Goldfussi p. p., Quenst. Petr. cxxvii. 19–22.

3. *Cnemidium corallinum*, Quenst. Jura, p. 84. 1; Petr. cxxvii. 16–18.

4. *Cnemidium rimulosum*, Goldf. vi. 4; Quenst. Petr. cxxviii. 1–5.
   Tragos granulosum, Quenst. Petr. cxxviii. 4, 5.

5. *Cnemidium pluristellatum*, Zitt.
   Cnemidium stellatum, Quenst. (non Goldf.) Jura, p. 676; Petr. cxxviii. 6, 7.
   ? *Cnemidium stellatum*, Goldf. xxx. 3 (non iv. 2).

*6. *Achilleum tuberosum*, Münst., Goldf. xxxiv. 4.

*7. *Achilleum cancellatum*, Münst., Goldf. xxxiv. 5.

8. *Cnemidiastrum Hoheneggeri*, Zitt. Lower White Jura, Wodna, near Cracow.

Corallidium, Zitt.

Cnemidium p. p., Quenst.

Sponge top-shaped, skittle-shaped, or cylindrical; vertex with a narrow stomachal cavity, from which radiate numerous extremely fine furrows, which traverse the sponge-body as vertical fissures. Sides completely coated with a dense, somewhat wrinkled envelope.

A single species in the Upper Jura of Kelheim.

1. *Cnemidium diceratinum*, Quenst. Handb. 1852, lxi. 20; Petr. cxxviii. 10–12.

† These references throughout are to plates and figures, except where otherwise expressed.

Hyalotragos, Zitt.

Tragos p. p., Goldf. (non Schweigger), Quenst. et auct.
Chenendopora p. p., *Cupulospongia* p. p., and *Chenendroscyphia* p. p., From.
? *Cymbochlænia*, ? *Bothrochlænia*, and *Diacyparia*, Pom.

Sponge cup-, plate-, funnel-, or top-shaped, pointed or shortly stalked below. Upper surface depressed, with irregularly scattered larger and shallow, or with crowded smaller oscula. Outer wall porous, or coated with a smooth, usually concentrically wrinkled covering-layer. In the middle of the depressed upper surface the openings of a greater or less number of vertical tubes which traverse the sponge-body to the base. In the wall, parallel to the surface, very fine radial canals run from the base to the upper margin; and as these are frequently arranged in radial vertical rows, a radiate structure like that of *Cnemidium*, but much finer and less distinct, is produced.

The skeletal elements, generally converted into calc-spar, are rather large, curved, with several, pronged branches, but with few spines on the shaft (see Pl. VIII. fig. 6). They are loosely interwoven, never grouped into fibroid trains, and produce a loose network well figured by Goldfuss (Petr. v. 10 *b*, xxxv. 5 *b*). Thus the whole sponge-body is traversed by a capillary network of canals, and the skeleton really constitutes only the very fine walls of these canals. Where the latter are close together, as in the centre, they usually acquire a polygonal form, and somewhat remind one of the tubes of *Favosites*. It is only on the surface (and both on the outer and inner surfaces) that the skeletal corpuscles are more closely interwoven, sometimes forming a smooth siliceous epidermis which appears dense to the naked eye.

This genus, which is very abundant in the Upper Jura, differs from *Cnemidiastrum* chiefly in the absence of coarse radial fissures; and from the Cretaceous genus *Verruculina*, besides the different external form, by the looser, coarsely meshed skeleton, the form and simple canal of the skeletal elements and their grouping, and by the vertical canals.

Goldfuss has described several forms under the Aristotelian name *Tragos*, previously applied by Schweigger to a living horny sponge. Goldfuss, however, referred to *Tragos* several other siliceous and calcareous sponges; so that the retention of this name is inadmissible for two reasons. Quenstedt (Petref. cxxviii. & cxxix.) figures the Upper-Jurassic species admirably; nevertheless, owing to their generally bad state of preservation, their distinction is very difficult. The best specimens are from the Lower White Jura (zone of *Ammonites* *transversarius*) of the Cracow district; but these belong chiefly to undescribed species. In the Swabian and Franconian specimens the most distinctive characters have been destroyed by the process of fossilization and subsequent weathering, so that many of them are undeterminable.

All the species occur in the Upper Jura:—

*1. *Hyalotragos* (*Tragos*) *patella*, Goldf. v. 10 & xxxv. 4; Quenst. Petr. cxxviii. 26–28, cxxix. 1–3.

2. ? *Tragos radiatum*, Goldf. xxxv. 2; Quenst. Petr. cxxviii. 24, 25.

3. *Tragos reticulatum*, Goldf. xxxv. 5; Quenst. Petr. cxxix. 10–15.

4. *Tragos infrajugosum*, Quenst. ib. cxxix. 6.

*5. *Tragos rugosum*, Goldf. xxxv. 4.

6. *Tragos pezizoides*, Goldf. v. 8.

Tragos fistulosum, Quenst. Petr. cxxviii. 15–23.

Pyrgochonia, Zitt.

Tragos p. p., Goldf., Quenst.
Forospongia p. p., D'Orb., Pom.

Sponge cup-shaped, on both sides with margined verruciform very shallow oscula. Skeletal structure and canal-system as in *Hyalotragos*; vertical tubes but slightly developed.

The typical species (*Tragos acetabulum*, Goldf.) was referred by D'Orbigny to *Forospongia*; but as this name embraced forms belonging to various genera, and the diagnosis, "Spongiaire lamelleux ou cupuliforme, criblé de pores des deux côtés," is better suited to half a dozen other genera, it has been dropped. Rubbed specimens of this Upper-Jurassic genus may easily be confounded with *Hyalotragos*. Species:—

1. *Pyrgochonia* (*Tragos*) *acetabulum*, Goldf. v. 9; Quenst. Petr. cxxix. 7, 8, 18.

Tragos infranudatum, Quenst. ib. cxxix. 6.
Tragos verrucosum, Goldf. xxxv. 6.

Discostroma, Zitt.

Tragos p. p., Quenst.

Sponge disciform or flat funnel-shaped; upper surface convex, with crinkled pits and elevations, and with a central cavity, sometimes narrow, but rather deep. Skeleton and canal-system as in *Hyalotragos*. Only in the Upper Jura.

1. *Discostroma* (*Tragos*) *intricatum*, Quenst. Petr. cxxix. 20.

LEIODORELLA, Zitt.

Planispongia p. p., and *Tragos* p. p., Quenst.

Sponge lamellar, ear-shaped, undulated, sometimes nodular or incrusting. Both surfaces coated with a smooth, apparently dense covering-layer, from which project scattered, margined, round oscula. From these, short, somewhat bent canals, branched at the end, penetrate perpendicularly into the wall.

Sketeton consisting of a rather dense complication of branched lithistid corpuscles with short, simple axial canal, and their short thick branches furnished with a moderate number of pointed processes. Surface-layer formed of small pronged and branched corpuscles.

In its external appearance this genus represents the Cretaceous genus *Amphithelion*, just as *Epistomella* may be regarded as the Jurassic precursor of *Verruculina*. Both the Jurassic genera agree in their skeletal elements with *Hyalotragos*, *Cnemidiastrum*, and *Platychonia*, while the Cretaceous genera have much thinner corpuscles furnished all over with nodular or root-like processes. The axial canals of the former are short and fine, while those of *Verruculina* and *Amphithelion* are of considerable diameter, traverse the whole main stem, and sometimes run into the branches. Only known from the Upper Jura. Species:—

1. *Leiodorella expansa*, Zitt. Lobate or ear-shaped, forming rather thick leaves; margin rounded off. Oscula bordered, verruciform, scattered. Zone of *Amm. transversarius*, Wodna, near Cracow.

2. *Tragos tubatum*, Quenst. Petr. cxxix. 19.

Also several other species from the White Jura of Switzerland, Swabia, Franconia, and the Cracow district.

EPISTOMELLA, Zitt.

Planispongia p. p., and *Spongites* p. p., Quenst.

Sponge ear-shaped or lamellar, laterally stalked. Upper surface with scattered, margined, round oscula; under surface with pores. Stomachal cavities of the oscula moderately deep. Skeleton and canal-system as in *Leiodorella*. Rare in the Upper Jura.

1. *Epistomella clivosa*, Quenst. Petr. cxxxi. 4, 5.

PLATYCHONIA, Zitt.

Spongites p. p., and *Planispongia* p. p., Quenst.
Amorphospongia p. p., D'Orb.
? *Plococœlia*, Etal.

Sponge lamellar, ear-shaped, undulated, folded, rarely cup-or basin-shaped. Both surfaces porous. Canal-system very imperfectly developed, sometimes replaced by the loose texture of the skeleton; but frequently the water flows in numerous serially arranged capillary tubes through the whole length of the wall, which thus acquires a fibrous or radiate aspect (see Goldf. xxxiii. 5 *a*). Skeletal elements like those of *Hyalotragos*.

This genus closely approaches both *Hyalotragos* and *Chonella*. From the former it differs by its irregular but generally lamellar form, and the absence of large oscula and vertical canals; from the latter, by the different structure of the skeleton. Thus in *Platychonia* the rather large moderately ramified skeletal corpuscles are individually interwoven; the much smaller and more ramified and pronged elements of *Chonella* readily group themselves into coarse fibres, giving the skeleton a much denser structure. This structure, however, produces a well-developed canal-system; and in *Chonella* perpendicular canals penetrate the wall from the pore-like apertures of the surface.

Various species of this genus occur in the Upper Jura; but, mainly owing to the state of preservation, their distinction is a matter of much difficulty. Quenstedt formerly grouped them together as *Spongites vagans*; but recently he has distinguished several species under *Planispongia* (Petr. Bd. v. pp. 317–323).

1. *Platychonia* (*Spongites*) *vagans*, Quenst. Jura, lxxxii. 8.
2. *Platychonia auriformis*, Quenst. Petr. cxxxi. 1.
3. *Scyphia Schlotheimi*, Münst. Goldf. xxxiii. 5.
4. *Spongites triangulus*, Quenst. Petr. cxxxi. 2.
5. *Spongites stragulus*, Quenst. ib. cxxxi. 9.
*6. *Spongites feralis*, Quenst. ib. cxxxi. 14.
7. ? *Plococœlia obscura*, Etal. Leth. Br. lix. 16.

Bolidium, Zitt.

Amorphospongia p. p., D'Orb., Röm.
Amorphofungia p. p., From.
?*Lithosia*, ? *Cladolithosia*, Pom.
Stellispongia p. p., Röm.
Sparsispongia, Gein.
Achilleum p. p., Reuss.

Sponge nodose, with a rounded or warty surface, sometimes ramose, thick. Surface with fine pores only. Skeleton of small, nodular, curved corpuscles, branched at the ends. Surface near the base often covered with a dense layer of young interlaced skeletal corpuscles.

Under this denomination are included a number of amorphous sponge-bodies without large ostia or canals, resembling *Astrobolia* and *Chonella* in skeletal characters. They have hitherto been generally referred to *Amorphospongia*.

*1. *Amorphospongia palmata*, Röm. Spongit. xix. 8. Senonian, Sutmerberg.

ASTROBOLIA, Zitt.

Asterospongia p. p., *Stellispongia* p. p., Röm.
Cnemidium p. p., Reuss.
Cytoracea, Rhagosphecion, and *Asteropagia* p. p., Pom.

Sponge nodose, irregular. Surface with coarser or finer pores, from which slender canals penetrate the skeleton; on the upper surface larger oscula, which acquire a stellate appearance by their connexion with furrows. Skeleton uniformly composed of nodular elements branched at the ends, and agreeing in form with those of *Bolidium*.

The species of this genus, readily recognizable by the radiate oscula and irregular form, have been generally referred to *Asterospongia* or *Stellispongia*. These genera, however, are so composite that they cannot be sustained in the sense of D'Orbigny and Römer. For the forms with large pit-like oscula (*Stellispongia impressa*, Röm.) Pomel established the genus *Cytoracea*. The species occur in the Cretaceous.

*1. *Cnemidium conglobatum*, Reuss, Kr. xvi. 2, 3. Cenomanian.

2. *Cnemidium stellatum*, Reuss, ib. xvi. 1. Cenomanian.
Stellispongia Reussi, Gein. Elbth. vi. 3.

3. *Stellispongia Michelini*, Gein. Elbth. vi. 2. Cenomanian.

*4. *Stellispongia hemisphærica*, Röm. Spongit. xvii. 3. Senonian.

*5. *Stellispongia conglomerata*, Röm. ib. xvii. 4. Turonian, Salzgitter.

6. *Asterospongia globosa*, Röm. ib. xix. 5. Senonian, Sutmerberg.

7. *Asterospongia tenella*, Röm. ib. liv. 6. Senonian, Sutmerberg.

8. *Stellispongia plauensis* pp., Gein. Elbth. vi. 1 (non v. 7, 8). Cenomanian.

9. *Stellispongia impressa*, Röm. Spongit. xvii. 2. Senonian, Sutmerberg (Quenst. Petr. cxxxiii. 12).

?10. *Stellispongia grandis*, Röm. ib. xvii. 1. Sutmerberg.

The genera *Tretolopia*, *Adelopia*, *Pliobunia*, *Streblia*, *Pliobolia*, and *Psilobolia* of Pomel, from the Miocene of Oran, would come best here according to their external habit.

Chonella, Zitt.

Cupulospongia p. p., D'Orb.
Chenendopora p. p., auct.
Oculispongia p. p., *Stellispongia* p. p., Röm.
Cupulochonia, *Dischonia* p. p., From.

Sponge irregularly funnel- or plate-shaped, simple or compound, sometimes consisting of a contorted leaf, with a short stem or thickened root. Both surfaces with small oval or round pore-like apertures, from which straight or curved canals run into the interior of the wall, which consists of a complication of small, irregular filigreed and branched siliceous corpuscles. The ends of these skeletal elements are often united by a rather dense tissue of minute corpuscles of the same form, but less pronged. In the wall and on the surface there are many uniaxial spicules of variable form and size, and, isolatedly, small anchors with their three flukes bent backward.

The type of the genus is *Cupulospongia tenuis*, Röm., beautiful specimens of which have been obtained from Linden and Biwende.

Chonella differs from the allied genus *Seliscothon* only by the absence of a radial arrangement of the skeletai elements. By the older writers most of the species were referred to *Cupulospongia* and *Chenendopora*. In external appearance *Chonella* closely resembles *Chenendopora*, Lamx.; but the skeletal structure is very different. In *Chenendopora* the corpuscles are much larger, less branched, and beset with wart-like blunt tubercles, and the canals are stronger; there is also a long stem traversed by vertical canals.

All the known species are Cretaceous.

1. *Cupulospongia tenuis*, Röm. Spongit. xvii. 7. Senonian.
2. *Achilleum auriformis*, Röm. Kr. i. 3. Senonian, Peine.
3. *Cupulospongia contorta*, Röm. Spongit. xviii. 2. Cenomanian.
4. *Cupulospongia Rœmeri*, Gein. Elbth. i. p. 29, v. 1–6. Cenomanian.
5. *Chonella Geinitzi*, Zitt. Cenomanian.
   Stellispongia plauensis p. p., Gein. Elbth. p. 30, v. 6–8 (non vi. 1).

Closely allied to *Chonella* are probably Pomel's genera *Cnemaulax*, *Spongoconia*, *Tascoconia*, and *Pliobolia*, from the

Miocene of Oran, of which only the external form is known. Here also probably

Plococonia, Pom.

(Pal. d. l'Oran, p. 248.)

Spongia, *Plocoscyphia* p. p., auct.

Sponge consisting of mæandrically contorted thick lamellæ, stalked. Skeleton?

1. *Spongia contorto-lobata*, Mich. Ic. xlii. 1. Senonian, Tours.

Seliscothon, Zitt.

Scyphia, Goldf.
Spongia, Phill.
Chenendopora p. p., *Cupulospongia* p. p., and *Ocellaria* p. p., Röm.
Trachydictya and *Laosciadia*, Pom.

Sponge plate-, basin-, funnel-, or cup-shaped, stalked. Upper margin thick, rounded, or obliquely truncate. Wall composed of thin, radial, perpendicular lamellæ, separated by fissure-like spaces of the same breadth, which replace the canal-system. Upper (inner) surface with shallow round ostia, sometimes also with numerous pores. Under (outer) surface smooth, or clothed with a dense siliceous membrane. The ostia of the upper surface open directly into the radial fissures.

Skeleton composed of fine, irregularly branched, siliceous corpuscles, covered with spinous or root-like processes, and forked at the ends of the main branches. These corpuscles are close together in the vertical lamellæ, and intimately interwoven by their processes; and some of them project into the vertical canals, and attach themselves by their ends to the neighbouring lamellæ, forming, as it were, bridges (see Goldf. lxv. 5 *b*). At the surface the corpuscles are rather more strongly branched, and form a finely porous covering-layer, in which numerous bacillar spicules, pointed at both ends, are scattered.

This genus differs from *Chonella* by the radial lamellæ forming the wall, and by the absence of special canals. Sometimes the lamellar structure of the wall is less distinct, the lamellæ are bent and more frequently united by bridges, so as to produce forms difficult to classify, and constituting an almost insensible gradation to *Chonella*.

Pomel proposes two genera for these sponges:—*Laosciadia* for those furnished with distinct ostia, such as *S. plana*, Phill.; and *Trachydictya* for the species with a finely porous surface, like *S. Mantelli*. The latter genus is placed by Pomel with the Hexactinellidæ.

All the species are from the Middle and Upper Cretaceous.

1. *Spongia plana*, Phill. Geol. Yorksh. pl. i. fig. 1. Upper Chalk.
2. *Spongia capitata*, Phill. ib. pl. i. fig. 2. Upper Chalk.
*3. *Chenendopora explanata*, Röm. Spongit. xvi. 3. Senonian.
*4. *Scyphia Mantelli*, Goldf. lxv. 5. Senonian.
5. *Seliscothon Rœmeri*, Pom. sp. Senonian.
   Cupulospongia Mantelli, Röm. Spongit. xvii. 6 (non Goldf.).
6. *Cupulospongia gigantea*, Röm. Spongit. xviii. 1. Senonian.
7. *Cupulospongia marginata*, Röm. Kr. ii. 7. Senonian.
*8. *Ocellaria subtilis*, Röm. Spongit. vii. 5. Senonian (Quenstedt's pl. cxxxiii. figs. 4–7 represent species of *Seliscothon*).

Chenendopora, Lamx.

(Expos. Méth. p. 77, pl. lxxv. figs. 9, 10.)

Chenendopora p. p., auct.
Jerea p. p., Mich.
Bicupula, Platispongia, Cupulospongia, Court.

Sponge cup-, funnel-, or basin-shaped, thick-walled, generally more or less long-stalked, with a root-like branching base, rarely without stalk. Upper margin truncate or rounded, broad. Inner surface with depressed, irregularly distributed oscula, from which simple, straight or bent canals penetrate the thick wall, and terminate close to the opposite surface. Below, the canals become more and more oblique, and finally vertical tubes, which traverse the whole stalk and are continued into the roots. Outer surface sometimes with a finely porous, dense, wrinkled covering-layer.

The skeleton consists of branching corpuscles of considerable size, almost entirely covered with wart-like tubercles. The root-like ends of the neighbouring elements are interlaced, and form at the surface the above-mentioned covering-layer. In the stalk, the surface of which is usually furrowed longitudinally, the skeletal corpuscles are much elongated. Large bacillar spicules are tolerably numerous.

Lamouroux's genus has been made to include sponges of very different structure. The type species (*C. fungiformis*, Lamx.), as has been proved by Michelin, is not from the Jurassic of Caen, but from the Upper Cretaceous deposits of Normandy. It occurs with allied forms, roughly silicified, in Touraine, whence Courtiller has described a great number of badly characterized species under the above-cited generic names. At present Cretaceous species only are known.

1. *Chenendopora fungiformis*, Lamx. *l. c.*; Guettard, Mém. tome iii. pl. ix. fig. 1; Park. Org. Rem. ii. pl. xi. fig. 5; Mich. Ic. p. 130, pl. xxxiv. fig. 3 (non fig. 2).

To this or some nearly allied species belong the following forms described by Courtiller from the neighbourhood of Saumur:—

a. *Bicupula gratiosa*, *capitata*, *compressa*, *clavata*, *excavata*, *auricula*, *prolifera*, *pateræformis*, *lata*, *sinuata*, *conica*, Court. pls. xxxv.–xxxvii.

b. *Platispongia speculum*, *discus*, *verticalis*, *rupa*, *obliqua*, Court. pl. xxxviii.

c. *Cupulospongia glomerata*, *contorta*, *infundibulum*, *elegans*, *terebrata*, Court. pl. xxxix.

2. *Scyphia terebrata*, Mich. Ic. xxix. 4. Senonian.

3. *Chenendopora pateræformis*, Mich. ib. xxxvii. 2. Senonian.

4. *Chenendopora pocillum*, Mich. ib. xxxiii. 5. Senonian.

Jerea arborescens, Mich. p. p. Icon. xlii. fig. 23 (non 2 *a*), is the root of a *Chenendopora*.

Probably closely allied to *Chenendopora* are:—

Pœcilospongia, Court.

(Ep. p. 9.)

"Sponge cup-shaped, with the aperture more or less narrowed. Central cavity irregular, furnished with horizontal striæ or furrows and oscula. Outer surface uneven, often depressed; oscula chiefly placed in these depressions." Upper Cretaceous, Touraine.

Dimorpha, Court.

(Ep..p. 7.)

Tragalimus, *Dimorpha*, *Elasmalimus*, Pom.

"Lower part like *Cupulospongia*. Inner surface of the margin of the cup forming dilatations of various forms, which alone bear oscula on the outer surface, and nearly always unite by their upper parts, leaving only one or two small apertures at the vertex." Upper Cretaceous, Touraine.

Arabescula, Carter.

(Ann. & Mag. Nat. Hist. ser. 4, vol. xii. p. 464, pl. xvii. figs. 7–9.)

(*Recent.*) Sponge thin, incrusting; surface with pores and fine furrows. Skeleton consisting of curved, branched, filigreed skeletal corpuscles, which interlock with their neighbours and form a membrane-like expansion; they are smooth on the outer surface, set with small warts on the inner surface. Recent: Seychelles and English Channel.

Corallistes, O. Schmidt (em. Zitt.).

(Atlant. Sp. p. 22.)

(*Recent.*) Sponge cup- or basin-shaped, or bent disciform. Oscula on the upper (inner) surface. Skeletal corpuscles crooked, irregularly branched, with root-like processes at the ends, with knotty warts on the stem and branches. Axial canal following the branches, branched, rather wide, but indistinctly bounded, often appearing as if composed of several canals side by side. Both surfaces covered with a layer of forked anchors (Pl. VIII. fig. 9), the prongs of which lie in one plane, while the shaft is directed inwards. For the five living species of this genus see p. 244.

Nearly allied to *Corallistes* are probably the insufficiently characterized genera *Ægophymia*, *Pumicia*, *Cisselia*, *Scythophymia*, *Pleurophymia*, and *Histiodia* of Pomel.

Heterophymia, Pomel.

(Pal. de l'Oran, p. 143.)

Dactylocalyx, Bow. p. p.

(*Recent.*) Sponge fan- or leaf-shaped, undulately folded. Upper surface with large scattered oscula; under surface porous. Skeletal elements as in *Corallistes*, but the two surfaces with different isolated corpuscles. Under surface with long-stalked, somewhat bent anchors with short thick prongs, and large bacillar spicules. Upper surface with small, smooth, irregularly branching corpuscles. One species.

Dactylocalyx heteroformis, Bow. Mon. p. 86, pl. iv. figs. 1–4, from China.

The species bears the name of *Coscinospongia heteroformis*, Val., in the collection of the Jardin des Plantes. Pomel has proposed for the genus the name of *Heterophymia*, as *Coscinospongia* comes too near to *Coscinopora*. *Dactylocalyx* must be limited to a living Hexactinellid.

MacAndrewia, Gray.

(Proc. Zool. Soc. 1859, p. 438, pl. xv.)

Dactylocalyx p. p., Bow.
Corallistes p. p., Schmidt.

(*Recent.*) Sponge cup- or basin-shaped or clavate. Inner surface with scattered wart-like oscula. Skeletal corpuscles curved, branched, the ends root-like; main branches smooth, with a few spinose processes. Surface-spicules with a short pointed shaft, from the outer end of which three, bent, branched arms issue horizontally. Arms flat, with processes and branches on both margins. Also minute flesh-spicules pointed at both ends in great numbers. Two species.

MacAndrewia azorica, Gray, Bow. Mon. pl. v. figs. 1–5.
MacAndrewia (*Corallistes*) *clavatella*, Schmidt.

Azorica, Cart.

(Ann. & Mag. Nat. Hist. ser. 4, vol. xii. p. 442.)

(*Recent.*) Sponge cup-shaped, strongly folded, with a short stalk; on the inner surface wart-like oscula; on the outside fine pores; skeleton consisting of small, smooth, irregularly branched siliceous elements, with root-like branches at the ends; surface-layer with corpuscles of similar form, only differing from those of the interior by isolated knots. Flesh-spicules bacillar.

Azorica Pfeifferæ, Cart.

Leiodermatium, O. Schmidt.

(Atl. Sp. p. 21.)

(*Recent.*) Like *Azorica*, but the oscula on the outside.

Leiodermatium lynceus, Schmidt.

Verruculina, Zitt.

Spongia p. p., Phil.
Manon p. p., Röm., Reuss.
Chenendopora p. p., Mich., Röm., Gein.

Sponge irregularly funnel-, bowl-, ear-, or leaf-shaped, often curved, attached by a short stalk or sessile, margin rounded off. Oscula only on the upper (=inner) surface, on wart-like elevations. Lower (=outer) wall with numerous fine pores. From the oscula rather wide curved canals penetrate to about the middle of the thick wall, receiving innumerable capillary tubes from all sides. Rather finer canals run inwards from the pores of the outer surface.

By the numerous fine canals the small siliceous elements are grouped into anastomosing fibres, which appear like a vermiform tissue to the naked eye. Under the microscope these fibres prove to be formed of small, elongated, bent corpuscles, with many longer and shorter root-like lateral branches, closely interlaced by their lateral processes. Both surfaces of the sponge-body are covered with an apparently solid covering-layer; but this also consists of a close tissue of filigreed siliceous corpuscles, smaller than those of the wall, and with the processes sometimes more strongly developed. These are probably young skeletal corpuscles. This surface-layer, which also forms the tubularly elongated walls of the oscula, is separated by treatment with acid; and then there are usually seen on the surface simple or forked horizontal canals which open into the vertical tubes of the oscula. Of free siliceous structures there are straight or bent, pointed or blunt, bacillar spicules of different sizes.

This genus very closely approaches the existing genera *Azorica* and *Leiodermatium*, both in external form and in the microscopic structure of the skeleton. All three are characterized by the absence of a special surface-layer composed of anchor-shaped or disciform spicules, this being replaced by a dense layer of young corpuscles. *Verruculina* differs from these two genera in the larger size and gnarled condition of its skeletal corpuscles. From *Chenendopora*, Lamx., this genus differs in its wart-like oscula and short curved stomachal cavities, which reach only to the middle of the wall. *Chenendopora* also is always funnel- or cup-shaped, and has usually a long root traversed by vertical tubes.

All the known species of *Verruculina* are from the Middle and Upper Cretaceous.

1. *Manon micrommata*, F. A. Röm. Kr. i. 4; Quenst. Petr. cxxxii. 52. Quadratus-chalk, Sutmerbeg.

*2. *Manon seriatopora*, F. A. Röm. Kr. i. 6. Quadratus-chalk, Sutmerberg.

*3. *Manon Phillipsii*, Reuss, Böhm. Kr. xix. 7–9.

Chenendopora undulata, Gein. Elbth. vii. 5, 6 (non *C. undulata*, Mich. xxxiv. 3, necnon *C. fungiformis*, Lamx., Mich. xxxiv. 2). Cenomanian; Bohemia, Saxony.

4. *Manon distans*, F. A. Röm. Kr. p. 3. Quadratus-chalk, Goslar.

*5. *Chenendopora aurita*, F. A. Röm. Spong. p. 43. Quadratus-chalk, Hanover.

6. *Spongia marginata*, Phill. Yorkshire, i. 5; Quenst. Petr. cxxxii. 54. Upper Chalk.

Amphithelion, Zitt.

Manon p. p., Röm., Reuss.
Verrucocœlia and *Chenendopora* p. p., F. A. Röm.
Diplostoma p. p., and *Chenendroscyphia* p. p., From.
Stelgis p. p., *Cladostelgis* p. p., and *Pleurostelgis*, Pomel.

Sponge funnel-, basin-, ear-, or leaf-shaped, rarely branched, stalked, on both sides with wart-like oscula, those of the inner (=upper) surface usually larger. Canal-system, skeleton, and surface-layer as in *Verruculina.*

This is perhaps only a subgenus, its sole difference from *Verruculina* being that the elevated oscula are not confined to the inner surface. The outer oscula are generally smaller than the inner, sometimes reduced to fine, rounded, elevated pores.

Pomel has referred the species to three genera; but, curiously, for the principal genus, *Stelgis*, a Hexactinellid (*Ventriculites radiatus*, Mant.) is cited as the typical species.

All the species are from the Upper Cretaceous.

1. *Spongia osculifera*, Phill. Geol. Yorkshire, i. 3. Upper Chalk.

2. *Manon circumporosum*, Quenst. Petr. cxxxii. 55. Senonian.

*3. *Manon miliaris*, Reuss, Böhm. Kr. xix. 10–13. Cenomanian.

4. *Manon tenue*, F. A. Röm. Kr. i. 7. Turonian, Cenomanian.

Chenendopora tenuis, Quenst. Petr. cxxxi. 8, cxxxii. 44–48.

5. *Chenendopora crassa*, Röm. Spong. xvi. 1. Cuvieri-Pläner.

6. *Spongia convoluta*, Quenst. Petr. cxxxii. 49, 50. Upper Chalk.

7. *Verrucospongia macrommata*, Röm. Spong. xvi. 4. Senonian.

8. *Verrucospongia damæcornis*, Röm. Spong. xvi. 5. Cenomanian.

STICHOPHYMA, Pomel.

Manon p. p. Röm., Reuss.
Verrucospongia p. p., D'Orb., Röm.
Polyjerea p. p., Röm.
Stichophyma, Pom.

Sponge simple, rarely branched, cylindrical, clavate, top-shaped or nodular. At the vertex some usually margined and somewhat prominent orifices of vertical canals which penetrate the whole height of the sponge-body. On the sides also there are usually wart-like oscula, sometimes replaced by simple round apertures, communicating with horizontal canals. Besides these larger canals, fine radial canals run from the central axis towards the periphery. Base generally narrowed, but not stalked.

Skeleton composed of small, short, crooked, irregular corpuscles with many branches, covered on all sides with short root-like processes. At the surface these are sometimes very densely packed, forming a covering-layer which appears almost smooth to the naked eye.

The species were referred by D'Orbigny to *Verrucospongia*; but as calcareous and siliceous sponges of various genera were embraced under this name, it is desirable to drop it altogether, especially as there is a genus *Verrucocœlia* among the Hexactinellidæ.

All the known species are Cretaceous.

1. *Manon turbinatum*, Röm. Kr. i. 5. Senonian, Sutmerberg.

2. *Stichophyma serialis*, Pom. p. 188.

Manon turbinatum, Reuss, Böhm. Kr. p. 78, xix. 1–6. Cenomanian.

3. *Manon sparsum*, Reuss, Böhm. Kr. p. 78, xviii. 12–20. Cenomanian.

4. *Polyjerea verrucosa*, Röm. Spong. xiii. 5. Cuvieri-Pläner, Salzgitter.

The following imperfectly known genera may be best arranged near *Stichophyma*.

Allomera, Pom.

(Pal. d'Oran, p. 194.)

Sponge simple, oblique, attached by a thick stalk which is often very short, almost sessile, globular or elongated, truncated at the vertex, where in young individuals isolated vertical tubes, and in older ones a bundle of such tubes open. One side, which is made the upper by the oblique position of the sponge, is of perfectly dense structure; the surfaces of the other sides are covered with fine pores. These are developed especially on the surface turned downwards. Vertex dense, with fine furrows. Skeletal structure unknown. Miocene of Oran.

Pleuromera, Pom.

(Ib. p. 199.)

Sponge simple, lamellar, sessile. Lower surface with pores; upper surface dense, with a pit into which canals open. Margin thick, with fine furrows. Miocene of Oran.

Perimera, Pom.

(Ib. p. 200).

Polystoma p. p., Court. (non Zeder).

Sponge nodular, compound. The individuals with a round aperture in the vertex, communicating with a tubular stomachal cavity. Certain parts of the surface with pore-like apertures. Skeleton? Upper Chalk.

Polystoma boletiformis, simplex, elongata, lobata, contorta, irregularis, ambigua, &c., Court. Ep. xii. 5, 6, xiii. & xiv. Senonian.

META, Pom.

(Ib. p. 188.)

Sponge cylindrical, clavate or nearly globular. Oscula scattered in the vertex. Miocene, Oran.

MARISCA, Pom.

(Ib. p. 192.)

Sponge from pyriform to globular, with a radiated pit in the vertex, into which a bundle of fine excurrent tubes opens. Surface with scattered large pores. Miocene, Oran.

[To be continued.]

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

June 5th, 1878.—John Evans, Esq., D.C.L., F.R.S., Vice-President, in the Chair.

The following communications were read:—

1. "On the Affinities of the Mosasauridæ, Gervais, as exemplified in the Bony Structure of the Fore Fin." By Prof. Owen, C.B., F.R.S., F.G.S., &c.

In this paper the author commenced by discussing the opinions expressed by different anatomists as to the indications of relationship furnished by the structure of the fore limb, and stated that in 1851 he had referred *Mosasaurus* to a tribe Natantia, of the order Lacertilia. Since then Prof. O. C. Marsh has published a reconstruction of the fore limb of the Mosasauroid *Lestosaurus simus*; and from a comparison of his figure with the bones of the same parts in Cetacea, Plesiosauria, and Lacertilia, the author showed that the resemblance in structure was closest with the last-named type, of which the fore foot of *Monitor niloticus* was taken for comparison. In the relative length of the digits and the number and form of the phalanges the Mosasauroid fore foot was shown to agree most nearly with the Lacertilian type. With regard to the presence of a zygosphene and zygantrum in vertebræ of *Clidastes*, cited by Prof. Cope in favour of his approximation of the Mosasaurs to the Ophidia and his establishment of the order Pythonomorpha, the author remarked that the trunk-vertebræ of the Iguanidæ show zygosphene and zygantrum, but with modifications which serve to distinguish the

Iguanian from the Ophidian vertebræ, and that, until we have the opportunity of comparing the Mosasauroid vertebræ with those of both these types, the mere presence of these parts cannot be accepted as conclusive.

2. "On new Species of *Procolophon* from the Cape Colony, preserved in Dr. Grierson's Museum, Thornhill, Dumfriesshire; with some Remarks on the Affinities of the Genus." By Harry Govier Seeley, Esq., F.L.S., F.G.S., &c., Professor of Geography in King's College, London.

The species described by the author were named by him *Procolophon Griersoni*, *P. spheniceps*, and *P. platyceps*; they are represented by skulls imbedded in a hard red ironstone matrix, apparently concretionary, and were collected at Donybrook, Queenstown district, Cape colony.

With regard to the systematic position and affinities of *Procolophon*, the author remarked that the presence of two distinct nares shown in his specimens, removed the genus from the family Mononarialia, of the order Theriodontia, in which it was placed by its founder, Prof. Owen. He further discussed in considerable detail the characters upon which the order Theriodontia is founded, and arrived at the conclusion that this group must be regarded as synonymous with the family Cynodontia, which, with the Dicynodontia and Cryptodontia, make up Prof. Owen's order Anomodontia. The genus *Procolophon*, displaying no distinguishable canines, does not possess the chief character of a Cynodont; and the author preferred to regard it as belonging to a parent type from which the dental modifications of the Anomodontia have been derived, and, from its apparent relationship to *Hatteria*, as forming an extinct family of the Rhynchocephala. Hence the question arises, whether the Anomodontia and the South-African forms described as Dinosaurs might not be united with the Rhynchocephala to form a subclass of Reptilia.

3. "On the Microscopic Structure of the Stromatoporidæ, and on Palæozoic Fossils mineralized with Silicates, in illustration of *Eozoon*." By Principal Dawson, LL.D., F.R.S., F.G.S.

The fossils included in the group Stromatoporidæ occur from the Upper Cambrian to the Upper Devonian inclusive, and are especially abundant in the Trenton, the Niagara, and Corniferous formations. The author regards *Stromatopora* as a calcareous, non-spicular body, composed of continuous, concentric, porous laminæ thickened with supplemental deposit, and connected by vertical pillars, most of which are solid. The surface shows no true oscula; but perforations made by parasitic animals have been mistaken for such. From the structure, they cannot have been related either to Sponges or to *Hydractiniæ*, and still less to Corals; they are truly Foraminiferal, and may be regarded as the Palæozoic representatives of *Eozoon*. *Stromatopora* occurs infiltrated with calcite or silica, or with its structure wholly or in part replaced by crystalline silica or dolomite. The author concluded his first section with the characters of the genera which have been included in the Stromatoporidæ.

In the second part he noticed a number of facts relating to the occurrence of hydrous silicates, of the nature of serpentine and loganite, infiltrating palæozoic fossils and illustrating the mode of occurrence and mineralization of *Eozoon*. Instances of this kind were said to be exceedingly common, showing that such silicates, whether originating as direct deposits from water, or as products of the decomposition of other minerals, are efficient agents in the infiltration of the pores and cavities of fossils, and have played this part from the earliest geological periods.

4. "On some Devonian *Stromatoporidæ*." By A. Champernowne, Esq., F.G.S.

The author's object in this note was to give some account of the origin of a fine series of Stromatoporidæ presented by him to the Society. They were all from the Great Devon Limestone at Dartington, near Totnes, and were obtained from a spot in the Pit-Park Quarry, where the dolomitic rock, instead of being hard and crystalline, is friable and almost sandy. The Stromatoporidæ appear to have grown in the position in which they are found. They can be traced for a few yards from the friable portion of the rock, but gradually become merged in the crystalline rock; and then their internal structure is obliterated. The author noticed the various Corals, Crinoids, and Brachiopods which occur associated with the Stromatoporidæ. The author regarded the Stromatoporidæ as a somewhat heterogeneous mixture of organisms, but did not believe that they were, as had been asserted, originally siliceous. Some seem clearly to be of a structure like that of the Milleporidæ. With regard to *Caunopora placenta* (Lonsd.) the author quoted Prof. Phillips's remarks as to the characters of the tubes traversing its mass. He had observed in sections from near Teignmouth, that the axis of the tube is lamelliferous, giving some appearance of a columella.

Prof. Duncan expressed his belief that many different forms were united under the one head of *Stromatopora*, and that the confusion was often due to the mode of mineralization. He called attention to a *Smithia* exhibited, which, by destructive mineralization, had assumed a deceptive resemblance to *Stromatopora*. He thought this had been the case in some of Mr. Lonsdale's specimens. The tubules in the laminæ of *Stromatopora* certainly had much resemblance to the tubules of *Millepora*. Some of the specimens exhibited seemed to have openings like calices; as they opened into the cœnenchyma, they could not be corals. The cross tubules excluded them from Polyzoa. They showed no true supplemental skeleton, or nummuline layer like *Eozoon*; and so he doubted their Foraminiferal character. With regard to the mineralization, he had some years before received specimens of fossils from Canada, which Dr. Dawson's description had recalled to his mind.

Mr. Champernowne described the tubular structure which he had observed in some of the Stromatoporidæ from Devonshire, both in the horizontal and vertical sections, and felt certain that the group contained many different forms. He had never seen Eozoonal structure in the Devonshire fossils.

Dr. Murie stated that some specimens which he had seen resembled the Hexactinellidæ, and he thought they represented sponges, not precisely Hexactinellids.

5. "On a new Species of *Loftusia* from British Columbia." By George M. Dawson, D.Sc., F.G.S., Assoc. R. S. M., of the Geological Survey of Canada.

The specimens on which the genus *Loftusia* was founded in 1869 were brought from Persia by Mr. Loftus; and the rock from which they were derived was conjecturally assigned to the earliest Tertiaries. The species now described (*L. columbiana*) is found in a limestone probably of Carboniferous age, and occurs in the banks of Marble Cañon, Frazer River. This limestone appears to be very thick, but may be repeated by folds. Crinoidal columns and *Fusulinæ* have been sparingly found in it. Where the *Loftusia* is abundant it becomes almost the sole fossil; and it sometimes occurs as numerously as *Globigerinæ* in the Atlantic ooze.

Loftusia columbiana differs from *L. persica* in size, its longer diameter averaging about 0·3 inch, and its shorter one 0·19–0·2 inch. No regular furrowing of the outer surface has been observed, but some specimens show a tendency to acervuline growth. The structure is very like that of *L. persica* as described by Mr. Brady, although the nucleus is not quite so distinctly cancellated; the test consists of a primary layer coiled upon itself, with "secondary" septa very oblique to it, and "tertiary" columns expanding at the outer ends into cross-like "rafters," supporting the roof formed by the primary lamina. A loose cancellated growth also depends from the roof between these rafters, analogous to a more regular structure observed in *L. persica*. The usual number of convolutions is about 10; but as many as 17 have been observed.

June 19, 1878.—Prof. Prestwich, M.A., F.R.S., Vice-President, in the Chair.

The following communications were read:—

1. "On *Pelanechinus*, a new Genus of Sea-urchin from the Coral Rag." By W. Keeping, Esq., B.A., F.G.S., Professor of Geology in the University College of Wales.

In 1855 an Echinid was described by Dr. T. Wright, from very fragmentary specimens, under the name of *Hemicidaris corallina*.

Since that date two very fine specimens have been obtained, both from Calne—one by Mr. Keeping, sen., now in the Woodwardian Museum, Cambridge, the other in Dr. Wright's collection. These show the affinities of the Echinid to be rather with the Echinothuridæ. The author regards this species as the type of a new genus, which he names *Pelanechinus*, and characterizes as follows:—

Test thin, circular, depressed, consisting of (1) transversely elongated coronal plates, (2) apical plates, (3) an actinal system of imbricating plates around the mouth. *Interambulacral areas* narrow at poles, but rapidly broadening towards the equator, with 6–8 rows of primary tubercles; the plates narrow, contour rounded, slightly undulating. *Ambulacral areas* more uniform, equal to $\frac{1}{3}$ of the greatest breadth of interambulacral areas, with two rows of primary tubercles; poriferous zones broad; pores trigeminal in the equatorial region. *Primary tubercles* rather small, smooth, perforated, uniform over both areas; spines small, hollow. *Peristome* deeply notched. *Actinal area* about $\frac{3}{8}$ of whole test, covered with zones of large imbricating plates, with perforations and perforated tubercles. *Jaws* large and powerful.

This Echinid has a marked similarity of appearance to *Asthenosoma* (*Calveria*); and the author believes that it also had a flexible test.

2. "Remarks on *Saurocephalus*, and on the Species which have been referred to that Genus." By E. Tulley Newton, Esq., F.G.S., of H.M. Geological Survey.

In this paper the author gives an account of those species of fossil fishes from American and British Cretaceous strata which have been referred to the genus *Saurocephalus*, originally founded by Harlan in 1830, and regarded by him as showing Reptilian affinities. The ichthyic nature of the species first described, *S. lanciformis*, Harl., was demonstrated by Prof. Owen. By Agassiz and Dixon certain large fossil teeth from the White Chalk of Lewes were identified with *Saurocephalus lanciformis*; and the latter also figured an elongated rostrum as belonging to this fish. Dr. Leidy, in 1856, redescribed the original specimen of *Saurocephalus lanciformis*, and maintained that the jaws and teeth figured by Dixon do not belong to the genus *Saurocephalus*; he proposed for them the new name of *Protosphyræna ferox*. He thought also that the rostrum figured by Dixon belonged to a Sword-fish, and named the species *Xiphias Dixoni*. Specimens since obtained by Prof. Cope in America have proved that the rostrum and teeth actually belonged to the same fish, for the reception of which and of some American species Prof. Cope established the genus *Erisichthe*. The author maintains that Dr. Leidy's name, *Protosphyræna*, must be adopted for this genus, which will include the British *Protosphyræna ferox* (=*Erisichthe Dixoni*, Cope) and the American species, *P. angulata*, *nitida*, *penetrans*, and *ziphioides* (Cope). The characters of these species are discussed by the author. The species known on the Continent as

Saurocephalus albensis and *influens*, Pict. et Camp., *S. dispar*, Héb., and *S. inæqualis* and *substriatus*, Münst., are founded on isolated teeth; and their affinities are regarded by the author as doubtful. *Saurodon Leanus*, Hayes, from the Greensand of New Jersey, belongs to *Saurocephalus*, which also includes a species described by Prof. Cope under the name of *S. arapahovius*. Teeth erroneously referred by Agassiz to *Saurodon Leanus* were regarded by Dr. Leidy as representing a new genus and species, *Cimolichthys levesiensis*; and to this last-named genus the author refers *Spinax marginatus*, Reuss, and, doubtfully, *Saurocephalus striatus*, Ag.

3. "On some well-defined Life-zones in the Lower Part of the Silurian (Sedgw.) of the Lake-district." By J. E. Marr, Esq. Communicated by Prof. T. M'K. Hughes, M.A., F.G.S.

This paper treats of the zones of fossils occurring between the Coniston Limestone and Coniston Grits, with a view to establishing a boundary between the Cambrian and Silurian formations. In the lake-district beds the genus *Phacops* is very abundant, one or more species of its subgenera characterizing each fossiliferous formation. The zones thus indicated are found to hold good when the organic remains as a whole are considered. The author separates the Ashgill shales from the Coniston Limestone, giving separate lists of fossils to show the palæontological difference—from which it appears that but few (and those the very common Bala fossils) are common to both, while the most characteristic Ashgill fossils do not occur in the Coniston Limestone. They indicate that the Ashgill formation is Upper Bala. It is very irregular in thickness; and the author thinks this due to an unconformity above the Ashgill beds. Here the author agrees with Prof. Hughes in placing the base of the Silurian. He gives lists of the fossils in the basement bed and the Stockdale Shales, and points out that their facies is distinctly Silurian. Very few fossils are common to them and the Coniston Limestone or Ashgill Shales. Hence there is here both a physical and a palæontological break; so that the division between Cambrian and Silurian should be placed at this horizon. A detailed description (with lists of fossils) is given of the Coniston Flags and Coniston Grits. An appendix contains some palæontological notes on some species of the genus *Phacops*.

MISCELLANEOUS.

On the Parasitic Isopoda of the Genus Entoniscus. By M. A. Giard.

The singular parasitic Isopods discovered and described by Fritz Müller under the generic name of *Entoniscus*, have hitherto been detected only on the coast of Brazil. I have to indicate the existence of some species of this genus on the shores of the Loire-Inférieure, and to make known some new peculiarities of their degraded organization.

The commonest species occurs under the carapace of *Grapsus marmoratus*, Fab. (*varius*, Lat.), a crab which is very abundant on the rocks of Pouliguen. I shall call it *Entoniscus Cavolinii*, as it seems to be very probable that Cavolini saw the female of this species and described it as a gall produced on the viscera of the *Grapsus* (*Granchio depresso*, *Granchio spirito*) by the oviposition of the *Oniscus squilliformis*, which is simply the young of the *Entoniscus* at the moment of its escape from the ovigerous sac*.

Entoniscus Cavolinii differs considerably from the two species studied by Fritz Müller. The fringed laminæ, so highly developed on the ventral part of the thorax of *Entoniscus porcellanæ*†, do not exist here; nor do we find the sword-shaped abdominal feet. These two characters approximate our species to *Entoniscus cancrorum*, the parasite of *Xantho*. But while in the latter the abdomen has a continuous undulated fold only on each side of the first two segments, we find in *E. Cavolinii* five pairs of lamellar appendages, folded and undulated, corresponding to the five pairs of ramified appendages of the abdomen in *Ione*. These appendages diminish towards the extremity in such a manner that in appearance the first pair forms two large lateral tufts, and the following four a median posterior tuft, equivalent to each of the first two. The ovary presents four lateral prolongations, two anterior and two posterior, besides two or three pairs of less-visible eminences, no doubt corresponding to the thoracic feet which have disappeared; it also presents two long median dorsal prolongations. Analogous lobes are observed on the female of the *Cryptothiria balani*‡. These lobes, which are very regular and constant, were not seen by Fritz Müller. I believe that those of the dorsal parts recall morphologically certain features of the *Zoea*-form.

The embryo likewise presents very clear differential characters. The front is nearly straight, as in *Entoniscus porcellanæ*. Besides the lateral eyes, which are double and correspond to the definitive eyes of the normal Isopoda, it possesses a median eye, formed by two contiguous crystallines, some pigment, and optic nerves. It is the Nauplian eye that has persisted, with a structure identical with that which it presents in a multitude of Copepods; and it disappears afterwards, together with the secondary eyes, in the retrograde metamorphosis of the female *Entoniscus*. This fact appears to me of great importance, as indicating a trace of the *Nauplius* phase in the ontogeny of the Isopoda. Each of the first five pairs of thoracic legs terminates in a prehensile hand, the penultimate joint of which

* Cavolini, Memoria sulla generazione dei Pesci e dei Granchi. Napoli, 1787, p. 180 *et seqq.*

† See Ann. & Mag. Nat. Hist. ser. 3, vol. x. p. 87 (1862).

‡ I have been able to examine this curious parasite at Wimereux, where it is met with from time to time in *Balanus balanoides*.

is oval and bears two denticles on the side which faces the opposable tooth. The sixth pair of thoracic limbs, which is so important in characterizing the *Entonisci*, in no way resembles those of the known species. It is composed of five joints: that which corresponds to the hand of the other pairs is more elongated, and terminates at its inner margin in a small fixed tooth; its external margin is produced into a straight bacillus, as long as the joint which bears it, and furnished at its extremity with a tuft of rigid hairs.

The five pairs of abdominal limbs are all constructed in the same fashion. The terminal setigerous joint presents a straight margin which bears two rays; a third is inserted at the extremity. The heart is situated at the dorsal part of the first abdominal segment; it is found in the same place in the adult, where it never projects into a sac as in *Entoniscus porcellanæ.*

These embryos live very well in sea-water, in which they swim in the manner described by Fritz Müller,—that is to say, with the body bent towards the ventral side and the sixth pair of thoracic legs projecting on each side.

The second species that I have observed is much rarer. It lives as a parasite in *Portunus puber*; and whereas one may meet with an *Entoniscus Cavolinii* in about every thirty specimens of the *Grapsus*, the parasite of the Velvet-Crab does not occur in the proportion of more than 1 per cent. Moreover I have observed the latter only in *Portuni* collected at the island of Leven, opposite the point of Pen-Château. I have found two in the same *Portunus.* This species I name *Entoniscus Moniezii*, dedicating it to my preparator, R. Moniez.

E. Moniezii differs from *E. Cavolinii* in the colour of its ovigerous sac, which, at maturity, is of a nankeen-yellow colour, and not lead-grey as in the parasite of the *Grapsus.* The ovarian gland is yellow with a rose tinge; it is straw-yellow in *E. Cavolinii.* A female of *E. Moniezii* not yet entirely degraded has enabled me to study more thoroughly the phenomena of retrogression presented by these Isopods. The description of these phenomena will form the subject of a detailed memoir, in which I shall also indicate the taxonomic results which I have obtained by the study of the Isopoda of the family Bopyridæ.—*Comptes Rendus,* August 12, 1878, p. 299.

Note on the Saurus lucioceps *of Ayres.*
By W. N. Lockington.

Saurus lucioceps, Ayres, Proc. Cal. Acad. Sci. 1855, p. 69.

Saurus fœtens ?, Cuv. & Val. xxii. p. 471 (*teste* Günther).

A large specimen of the fish described by Dr. Ayres was presented to the California Academy of Sciences, August 19, 1878, and has been examined by Mr. W. G. W. Harford, the Director of the Museum, and myself.

The result of our examination leads us to suspect that possibly *Saurus fœtens* and *S. lucioceps* may prove identical, as some of the characters which distinguished the young specimen of the latter (6 inches long), described by Dr. Ayres, from the former species disappear in the larger one now brought under our notice.

Dr. Ayres states that the lower jaw is the longer; but his type has the lower jaw somewhat shorter than the upper, as has also the large specimen.

The interorbital space in the young specimen is equal to the longitudinal diameter of the eye; but in the large individual, owing chiefly to the greater development of the upper orbital margin, the interorbital space is equal to once and a half the longitudinal orbital diameter. The proportion of the head to the body in both specimens is about as two to nine; and the fin-rays in both agree with Ayres's description.

The only characteristics which still lead us to doubt the identity of *S. fœtens* with *S. lucioceps* are the proportion of the head to the body, and the number of the scales in the lateral line, which in the large specimen is not less than 75, instead of 65 as in *S. fœtens*.

Probably the shortness of the lower jaw is caused by contraction in alcohol. Dr. Ayres always purchased and described fishes in their fresh condition; and doubtless the lower jaw, now the shorter, was slightly the longer when he described it.

The donor of the specimen, Dr. Trask, states that the fish is scarce, and that in 1873 it appeared off this coast, but the individuals were no larger than a sardine.

Length to tip of caudal fin 1 ft. $5\frac{3}{4}$ in.; width of interorbital space 1 in.; from tip of snout to eye $1\frac{1}{8}$ in.; longitudinal diameter of orbit $\frac{5}{8}$ in., ditto to first dorsal $6\frac{1}{2}$ in., ditto to pectorals $3\frac{7}{8}$ in.

Locality. Santa Cruz.

San Francisco, Aug. 21, 1878.

On the Causes of the Buzzing of Insects. By M. J. Perez.

Since the experiments of Chabrier, Burmeister, Landois, &c., the buzzing of insects is attributed to the vibrations of the air rubbing against the margins of the stigmatic orifices of the thorax under the action of the motory muscles of the wings. The latter organs are considered only to play a minimum part by modifying more or less the sounds produced by the respiratory orifices. I have repeated all the experiments of the above authors, and have not always arrived at the results announced by them, or I have thought that I could put upon them an interpretation different from theirs.

1. It is quite true that, by sticking together the wings of a fly (*Sarcophaga carnaria*), as Chabrier did, we do not prevent the sound from being produced, but not that the wings can thus be kept in a state of complete immobility. The flexibility of these organs

allows their base, which is not stuck, to obey the contractions of the muscles of flight; this base vibrates, and the buzzing is produced. But all buzzing ceases if, by holding the wings pressed together over as large an extent as possible, so as to exert a certain traction upon their bases, all movement of those organs is rendered impossible. However the wings be retained, provided their immobility be complete, the buzzing absolutely ceases, contrary to Hunter's opinion.

2. By removing the scaly parts with which the margin of the stigmata is furnished, far from doing away with the buzzing, as asserted by Chabrier, it is not even modified, provided the operation has not sensibly weakened the animal.

3. The respiratory orifices may be more or less seriously injured in different ways, we may introduce into them solid bodies of considerable size, without preventing the buzzing or altering its *timbre*.

4. If the thoracic stigmata be stopped hermetically, as was done by Burmeister, the buzzing is by no means annihilated; it is only weakened in proportion to the weakening of the flight itself.

There are then produced, especially in the Diptera, effects which merit notice. The animal becomes slow and lazy and no longer flies willingly. If it flies, its flight, which is badly sustained, soon stops; then the insect sinks down and gives no more signs of life. I once saw an *Eristalis* (*E. tenax*) which, having escaped quickly from my fingers towards the window after the occlusion of its stigmata, fell without movement at my feet, completely exhausted by a flight of a few centimetres. This result is not always produced so rapidly; but it never fails to supervene after a few efforts at flight. It is easily explained by the complete absorption of the provision of oxygen contained in the tracheæ of the thorax, in consequence of the contractions of the muscles of flight. It is a true asphyxia. In a few minutes, however, the fly returns to life, owing to the afflux of air through the abdomen into the thorax. The animal can then again attempt to fly, or at least to walk; but actual death is not long in coming. These effects are so constant and easily obtained, that it is truly surprising that no experimenter has called attention to them.

The causes of the buzzing certainly reside in the wings. It has long been recognized that the cutting of these organs more or less near their insertion has a more or less marked influence upon the buzzing. It becomes thinner and sharper; the quality itself is notably modified. It loses the softness (*velouté*) due to the friction of the air upon the margins of the wings, and becomes in a manner "nasal." The *timbre* perceived under these circumstances resembles that of reed instruments, or still more that of certain electrical contact-breakers, and has no resemblance to the sound that can be produced by the passage of air through an orifice. This sound is, however, completely in relation to the repeated beatings of the wing-stump against the solid parts surrounding it, or of the corneous pieces which it contains (*osselets radicaux* of Chabrier), against each other.

If, in an animal treated as above, the wing-stump is coated with a slightly fluid substance which the air only dries slowly, the preceding sound is sensibly dulled, without the stigmata being in any way modified or the movement of the wings hampered.

When the section affects the stump itself, the sound produced becomes sharper and weaker. It is destroyed as soon as a sensitive part is reached; but this, as may be easily ascertained, is because the animal ceases to perform movements which have become painful.

To sum up, in the Hymenoptera and Diptera the buzzing is due to two distinct causes:—one, the vibrations of which the articulation of the wing is the seat and which constitute true buzzing; the other, the friction of the wings against the air, an effect which more or less modifies the former. It would not be impossible from these data to produce artificially the buzzing of these animals; and I have some hope of succeeding in this.

In the Lepidoptera of strong flight, such as the Sphinxes, the soft and full buzzing which those animals produce is only due to the friction of the air by the wings. This sound, which is always grave, is alone produced; it is not accompanied by the basal beatings, owing to a peculiar organization, and especially to the presence of the scales.

In the Dragonflies also, in which the base of the wings is furnished with soft fleshy parts, no true buzzing occurs, but a simple rustling due to the friction of the organs of flight.—*Comptes Rendus*, September 2, 1878, p. 378.

Reproduction of Hydra. By M. Korotneff.

Notwithstanding its abundance, the freshwater *Hydra* presents many peculiarities which have been insufficiently studied, especially the reproduction of the several elements and the embryonic development of the individual itself. These phenomena have been described in detail by Kleinenberg in his monograph on *Hydra* *. According to his investigation, the cells occur below the ectodermal elements (*interstitielles Gewebe*), and form an agglomeration serving to produce the ova as well as the spermatozoids. The development of the ovum takes place as follows:—One of the cells of the agglomeration increases remarkably, and swallows up the surrounding cells; in other words, it feeds upon them. The nucleus is transformed into a germinal vesicle; and finally the cell itself represents the ovum

* *Hydra*, eine anatomisch-entwicklungsgeschichtliche Untersuchung: Leipzig, 1872, with four plates.

of the *Hydra*, which is thus, in its origin, a unicellular and ectodermic formation.

The granulations of a definitely formed ovum serve to produce the larger elements which Kleinenberg describes under the name of *pseudocells.*

After a detailed description of the segmentation, the German naturalist passes to the formation of the blastoderm, as a phenomenon immediately succeeding the segmentation. The blastoderm consists of a layer of cells, forming by itself the whole envelope of the ovum. Kleinenberg regards the blastoderm as an embryonic epithelium, taking no part in the ultimate formation of the *Hydra*, but rejected like an envelope at a certain period of development; for this reason the adult *Hydra* is an animal destitute of epithelium.

My own investigations, which were carried on upon *Hydra fusca*, completely contradict those of Kleinenberg. Nevertheless, in conformity with his researches, I have seen an agglomeration of cells of ectodermic origin, which I regard as simply embryonic cells, serving to reproduce different ectodermic elements. One of these cells increases, and its nucleus is converted into a germinal vesicle. At the same time the peripheral elements of the agglomeration separate, forming a row of cells with small very refractive granules, while the central cells unite to each other and to the enlarged cell; in this manner is formed a common plasmodium sprinkled with a considerable number of nuclei. The germinal vesicle begins to be degraded and disappears entirely (this last phenomenon agrees with Kleinenberg's observations); but the nuclei of the central cells undergo a transformation of another kind: they increase a little in volume, and degenerate into fatty bodies; at the same time some of them divide (their nuclei also take part in this division). The degeneration of a nucleus commences by a considerable increase of its nucleolus, which becomes very refractive, and finally fuses with the contents of the nucleus. It is these degenerated nuclei, which probably serve for the nutrition of the embryo, that Kleinenberg takes for pseudocells. The peripheral elements of the agglomeration, sprinkled with granules of chitinous origin, serve to form the shell (*écaille*) or envelope of the ovum.

Comparing my observations with those of Kleinenberg, I conclude that the German naturalist has taken the peripheral cells of the agglomeration for a blastoderm, and the mass of central cells for a result of the segmentation of the ovum. According to my observations the *Hydra* must evidently not be regarded as an animal destitute of epithelium; my previous investigations * have proved that this epithelium is muscular.—*Comptes Rendus*, September 9, 1878, p. 412.

* Archives de Zoologie expérimentale, 1876: "Histologie de l'Hydre et de la Lucernaire."

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XXXVIII.—*On the Structure and Affinities of the Genus* Catagma*. By W. J. Sollas, M.A., F.G.S., &c.

[Plate XIV.]

In a previous paper I referred certain kinds of fossil Spongida (*Manon macropora*, *Jerea mutabilis*, *Scyphia foraminosa*, and others from Upware and Faringdon) to the group of the Renierida (Carter), on the ground that the calcareous fibres which form their skeletons are largely made up of long uniaxial spicules lying lengthwise in the fibre, and so far resemble the skeletal structure of *Pharetrospongia*. At the same time I was well aware that the fibres of the Faringdon sponges contain other kinds of spicules besides the simple acerates; but these I then regarded as accidental, and upon consulting Mr. Carter found that he agreed with me in thinking that a Renierid sponge might easily have imbedded some extraneous spicules in its fibres, after the manner of the Hirciniadæ, without thereby losing its Renierid character. But upon coming to work out these sponges in detail it was soon found that these second sets of spicules, from their abundance and definite position, constituted a peculiar difficulty; and the fact that Professor Zittel had, upon mature consideration, decided to place the Faringdon sponges with the Calcispongiæ on account of the presence of these particular spicules in them, led me to hesitate before reaffirming my previous conclusions, and to submit the whole subject to renewed investigation.

* Κάταγμα, worsted.

It is a matter of great regret to me that other duties have precluded me from finishing this work during the past year; but as Professor Zittel is about to publish another of his exhaustive monographs on the fossil sponges, this time dealing with those characterized by a reticulate calcareous skeleton, it seems, on the whole, best for me to publish at once the observations I have already made without waiting an indefinite period longer for fresh facts to come to light.

On examining a thin slice from *Manon macropora*, *marginatum*, or *porcatum*, one will observe an irregular network of anastomosing calcareous fibres, with rounded meshes filled up with crystalline calcite, the crystals of which radiate from the sides of the fibre towards the centre of the mesh. The edges of the fibre are usually coated with an opaque, granular or fluffy material suspended in the adjacent calcite; and the minute interstices between the infilling crystals of calcite are usually occupied by an insoluble yellowish-coloured mineral which has no action on polarized light. The fibres, under a magnification of 145 diameters, are found to consist of a brownish-coloured calcite, often fibrous in appearance, containing a number of spicular forms of two kinds, the most numerous of which are slender thread-like forms, 0·0003 inch to 0·0004 inch broad, but of indeterminate length, since in no single instance has a perfect spicule showing both ends been observed: the longest measured portions attain a length of 0·012 inch; how much longer an entire spicule would be we have no means of judging.

These spicules are sometimes straight or nearly so (Pl. XIV. fig. 5), but more usually bent, either in a gentle curve parallel to the curvature of the fibre (Pl. XIV. fig. 2) or in several curves so as to become undulating (Pl. XIV. figs. 3 & 4). Sometimes they are abruptly bent in somewhat angular turns (Pl. XIV. fig. 3). They are not so crowded together as in *Pharetrospongia*, but, lying further apart, somewhat resemble a number of pieces of thread floating in a viscid medium.

The second kind of spicules is indicated by sections which have very different shapes according to the direction in which they traverse the spicule. The simplest shape of all is a circular space (Pl. XIV. fig. 9) which is filled with colourless transparent calcite, and is of course a transverse section through a more or less cylindrical shaft. In the centre of this circular section there is very frequently visible a minute opaque spot, which appears black by transmitted light; it possibly represents the axial canal of the spicule. Transverse sections through the uniaxial spicules would have a similar form; but the two, independently of other differences, can be often distinguished by their great difference in size, the circles in question often attaining a diameter of 0·001 inch. As the sections through the cylindrical rods thus indicated vary from longitudinal to transverse, so different forms are produced. Next, one meets with a number of triradiate forms, sometimes with the three rays inclined to one another at an angle of 120°, sometimes less equally inclined.

The ends of the rays are frequently seen, and prove to have had an elongated conical form. The central space, from which the arms radiate, frequently shows a cut surface, eminently suggestive of the former existence of a fourth ray which the section has removed. Thus, in Pl. XIV. fig. 6, we have the triradiate remains of a spicule with a cut surface in the centre, circular in shape, and certainly due to the cutting away of an arm which projected at right angles to the plane of the section. In Pl. XIV. fig. 14 the part cut away includes the upper part of the three remaining rays; and in this case we cannot say whether a fourth arm was originally present or not. So, again, the form of fig. 7 is inconclusive; the cut surface looks rather as if taken from one of the rays (*r*) still remaining than from one once at right angles to them. Even if this were the case, there is still a possibility of a fourth arm being given off on the opposite side, which should be visible on turning the section upside down. Unfortunately my slice is mounted on too thick a glass to permit of examination under a sufficiently high magnification to decide this point. Thus, though sections having a triradiate form abound in slices of the sponges under examination, it is only in certain cases that they indicate truly triradiate spicules. As the mounted slices of our sponges are not mathematical planes, but possess a sensible thickness, so it is possible to see something more than a mere section across a spicule; and thus we can very definitely make out the existence of numerous quadriradiate forms in the fibre (Pl. XIV. fig. 17). These very much resemble the spicules of a *Pachastrella* (Pl. XIV. fig. 13), one longer simple shaft dividing into three shorter simple arms at one end.

Irregular forms with apparently bifurcated rays are not uncommon; and one instance of a five-radiate spicule has been observed.

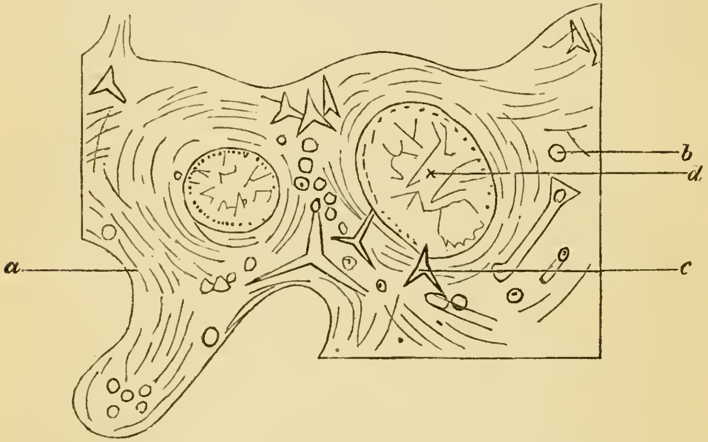
The shaft is not always straight, but sometimes becomes curved or even almost undulating (Pl. XIV. fig. 18); the rays likewise are sometimes curved (Pl. XIV. fig. 11). In size and in the relative length of the rays and shaft these spicules vary greatly. In some the rays are scarcely of larger diameter than the filiform spicules; in others they are several times as large, and appear giants by comparison.

The longitudinal sections of the spicules generally exhibit a number of opaque dots, usually irregularly dispersed; so that one of them occurring in a transverse section would simulate an axial canal cut through. This makes one less sure that axial canals really exist in these spicules; but since the dots sometimes take a linear arrangement in the longitudinal sections (Pl. XIV. fig. 16), they may, after all, indicate axial canals which have been partially filled up.

Relative Position in the Fibre of the two kinds of Spicules.

The filiform spicules chiefly occur in the outer part of the fibre, often forming the exterior third on each side, though sometimes less and sometimes, on the other hand, more of it, in some cases apparently occupying nearly the whole of the fibre almost to the exclusion of the other kind of spicules.

Fig. 1.



Section (partly diagrammatic) across fibres near the external surface of *Catagma macroporus*. (× 70.)

a, uniaxial spicules; *b,* transverse section of a multiradiate; *c,* echinating multiradiate spicules; *d,* interspace of a mesh, lined with granular material and filled up with calcitic crystallization.

The multiradiate spicules are usually axial in position, forming a core which is about one third the diameter of the whole fibre, though sometimes wider. This core looks, at first sight, like a congeries of irregular calcite crystals; but upon very careful analysis by the microscope it is seen to consist of circular and triradiate sections across the multiradiate spicules. It very frequently happens that one ray of a multiradiate is directed from the core outwards to the exterior of the fibre, beyond which it projects echinately, having crossed the longitudinal acerate spicules transversely in traversing the fibre. Sometimes a row of two or three multiradiates may be seen lying side by side, each echinating the fibre in this manner.

In one or two instances the fibres radiating towards and terminating against the surface of the sponge exhibit near their extremities a few multiradiates (Pl. XIV. fig. 20), which are disposed with their long shafts parallel to the axis of the fibre and their pointed terminal rays directed towards the exterior of the sponge. More usually the reverse is the case, however, and two of the rays lie transverse to the fibre, the other pointing axially outward. Sometimes, again, a triradiate form may be seen at the place of anastomosis of three fibres, sending a ray along the axis of each fibre.

The foregoing observations lead us to characterize the skeleton of *Catagma* in the following manner:—Skeleton consisting of an irregular network of fibres, now possessing a calcareous composition, built up of spicules of two kinds: one kind uniaxial, straight, simply curved or undulating, arranged longitudinally in the exterior third of the fibre; the other kind multiradiate (3- and 4-radiate), with the adjacent rays of each spicule making an angle of 120° with each other, or thereabouts; three of the rays occupying the interior or core of the fibre, the fourth directed outwardly and penetrating the layer of uniaxial spicules to echinate the exterior of the fibre.

Our next inquiry must be directed to determine the particular group to which this structure belongs. We have five orders to choose from, the Psammonemata, Chalinida, Echinonemata, the Tetractinellid division of the Holorhaphidota, and the Calcispongia.

The large proportion of structureless calcite occurring in the fibre seems to indicate the previous existence of kerataceous cement, which has since become replaced by carbonate of lime; but even if kerataceous material is so indicated, which is very doubtful, it cannot be taken as pointing to the Chalinida especially, since other groups of sponges, such as the Rhaphidonemata, also contain this substance. The Chalinida are, indeed, definitely excluded, not only by the presence of the multiradiate spicules, but also by the forms of the uniaxial spicules, which are quite inconsistent with Chalinid affinities.

The structure of the fibre is also unlike that of any Psammonematous sponge; but, in order to decide whether it might not have belonged to a sponge which possessed an Hircinian habit, thin slices of the Upware specimens, which include grains of quartzose sand in the meshes of their network, were examined. As the Hirciniadæ do not appear to discriminate in introducing foreign particles into their fibres, but pick up any minute grains which lie upon the sea-floor around them, so one would expect to find some of the quartz grains which occur in the meshes of the Upware sponges also present in the fibre had they possessed any affinities with the Psammonemata. Such quartz grains might easily be detected by searching with the polariscope; but a most careful examination failed to discover the least trace of them. Thus we eliminate the Psammonemata; and we have next to consider the Pachastrellidæ, to the trifid spicules of which the multiradiates of our sponges offer the closest resemblances.

In no Pachastrellid sponge, however, so far as I am aware, have we the curved and undulating uniaxial spicules of *Catagma*, nor is there to be found any definite fibrous structure. Thus we eliminate the Pachastrellidæ, the only Tetractinellid group of the Holorhaphidota that is worth considering. Far otherwise is it, however, with the Rhaphidonemata. The fibrous structure is not only common, but may be said to be characteristic of a vast number of this kind of sponges; curved and undulating spicules, very like those of *Catagma*, are also very frequent; and lately I have described a unique form (*Plectronella papillata*) in which triradiate and quadriradiate spicules, very similar to those we have been describing, are abundantly present.

One important difference alone (though certainly that is important enough) divides *Catagma* from the Rhaphidonemata; and that lies in the fact that the echinating multiradiates of the former form the core of the fibre instead of merely coating its exterior; but this is no more than the difference which distinguishes the Axinellida from the Ectyonida, the two families of Carter's order Echinonemata; and there is no difficulty in conceiving that, just as *Plectronella* presents us with a new departure in the Ectyonida by the substitution of multiradiate for uniaxial echinating spicules, so *Catagma* may represent a similar departure in the Axinellida.

This certainly is the view which I feel disposed to take; and so important does this substitution of multiradiate for biradiate echinating spicules seem to me, that I propose to elevate my group Plectronina to the rank of a subfamily in the Ectyonida, and to make the extinct *Catagma* the representative of a subfamily in the Axinellida. The classification would then stand thus :—

Order RHAPHIDONEMATA (Carter).

Family **Ectyonida** (Carter).

Subfamily *Plectronellida* (Sollas).

Family **Axinellida** (Carter).

Subfamily *Catagmida* (Sollas).

There now remain for consideration the counterclaims of the Calcispongia, which find an advocate in Professor Zittel, with whom it is my misfortune on this sole point to find myself in disagreement. The occurrence of triradiate spicules in *Catagma* appears, independently of its chemical composition, to be the only point in which it resembles the Calcispongia; in the structure of the fibre, which is, after all, a far more important character, the difference is complete; and no calcareous sponge has yet been discovered which presents us with curved and undulating uniaxial spicules like those of our sponge. Moreover, while the axial canal of calcareous spicules is so small as to be almost invisible, that of the multiradiate spicules of *Catagma* is sometimes apparently indicated. Nor, in reference to this, can it be urged that the axial canal of a calcareous spicule would be likely to undergo an enlargement as it became subject to fossilizing processes. In the case of a siliceous sponge, it is true that on exposure to the carbonated water of the sea-floor, solution sets in and soon enlarges the axial canals of its spicules till they become visible. But while solution equally affects calcareous spicules, it does so in a very different manner: instead of the axial canal undergoing enlargement, the whole substance of the spicule resolves itself into a granular mass, from which the original structure is quite obliterated, and in which certainly no signs of a canal can be traced. Fig. 2 (p. 360), taken from a decomposing spicule of a *Leuconia*, will clearly show this.

So far as the zoological argument goes, then, it may be summed up thus:—

1. (*a*) No known calcareous sponge possesses a reticulate skeleton with definite fibres having a spicular composition.

(*b*) Such a structure is exceedingly common among the siliceous sponges.

2. (*a*) No known calcareous sponge possesses long curved and undulating uniaxial spicules.

(*b*) Siliceous sponges (ex. gr. *Phakellia*, Bwk.) frequently contain spicules of this form.

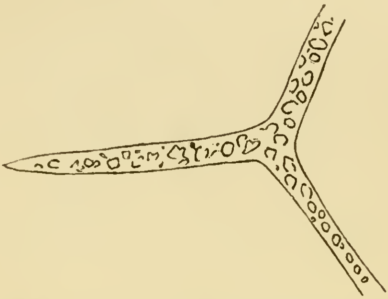
3. (*a*) Calcareous sponges usually contain triradiate and quadriradiate spicules.

(*b*) Siliceous sponges frequently contain quadriradiate, sometimes triradiate spicules (*Plectronella*; for other instances see my paper on *Plectronella*, in a forthcoming number of the 'Annals').

4. (*a*) Calcareous sponges are usually small, and seldom exhibit the external characters of *Catagma*.

(*b*) Siliceous sponges often closely resemble *Catagma* both in size and form.

Fig. 2.



Spicule of a *Leuconia* (× 435), to indicate the granular manner in which it begins to disintegrate.

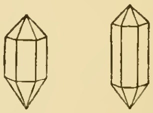
Next, and finally, we have to consider the mineralogical side of the question. Neither Professor Zittel nor myself doubt for a moment that siliceous structures may be converted during fossilization into carbonate of lime, and, conversely, that calcareous structures may become silicified: the only difference is as to which process has happened here.

We may observe, first, that while, on the one hand, we know of a vast number of cases in which siliceous sponges closely allied to existing species have been preserved in the fossil state, on the other hand not a single instance of a fossil calcareous sponge closely allied to any species of our existing seas has yet been described, the supposed fossil calcareous sponges differing widely in structural characters from existing forms. I have not, however, the slightest doubt as to the possibility and even probability of fossil calcareous sponges * being some day discovered. It is useless to allege that calcareous spicules are too unstable to survive the effects of such a feeble solvent as sea-water; that they soon disintegrate and lose their definite form when mounted in sections of the sponge

* *Protosycon*, Zittel, may be such a sponge.

to which they belong in Canada balsam is no doubt true, though even then they leave a thin transparent sheath behind, which, to some extent, maintains the original spicular form: no less true is it, according to Carter, that they break down when mounted dry or enclosed in the kerataceous fibre of a Psammonematous sponge; but when well cleaned by caustic potash and then mounted in balsam, they last much longer, and if placed in distilled water instead of balsam they will keep for years. I have now before me some calcareous spicules which were so prepared; and they are as perfect to-day, even to their points, as they were when bottled and put away four years ago. Thus there is no antecedent improbability about the preservation of calcareous spicules.

Fig. 3.



Quartz crystals left on dissolving Carboniferous limestone from Caldon Low, Derbyshire. (× 140.)

As regards siliceous sponges, we have, as has been said, numberless fossil examples, many of these often existing in a calcareous state; but it may be as well to note that when a siliceous sponge becomes calcitized in fossilization, the displaced silica is generally to be found somewhere not far off, either in patches in the sponge itself, or in granules or nodules such as flints in the surrounding matrix, or as chalcedony silicifying associated calcareous shells, *ex. gr.* in the Lias of the South-Welsh coast, or in minute dispersed crystals of quartz* (fig. 3), Devonian and Carboniferous. In compact strata, such as chalk or limestone, it may be taken as an almost invariable rule that the replacement of organic silica by calcite is always accompanied by a subsequent deposition of the silica in some form or other; and thus, if one finds flints, chalcedonized shells, or minute quartz crystals in such strata, one will naturally look for the remains of the siliceous organisms which supplied them, and one's search will seldom be unsuccessful.

On the other hand, when one finds large masses of such a

* Attention was first directed to these crystals by my friend Mr. T. Wardle, F.G.S., in a paper on "Limestone" read before the North-Staffordshire Field Club in 1873. They contain numerous irregular internal cavities, and are frequently twinned. Left as an insoluble residue after the solution of the Mountain-Limestone by the great Permian denudation, they have accumulated to form sandstone beds in the red rocks of the Eden valley, to which my attention was directed by Prof. Morris. Similar but much larger crystals (0·02 inch long) are left on dissolving Devonian limestone containing the so-called *Stromatopora concentrica*, from Kingsteignton, near Teignmouth. These are completely riddled internally and much excavated on their faces externally by irregular cavities.

fossil as *Caunopora* forming limestone beds several feet in thickness, and no obvious deposits of silica associated with them, one may feel tolerably certain that these fossils have always possessed a calcareous and not a siliceous composition.

Now the importance of this observation is, that the Faringdon and Upware sponges do not contain any trace of silica, unless it enters into the composition of the yellowish, transparent, insoluble mineral which fills up the interstices of the calcitic infilling of the sponge. It would be difficult to make an analysis of this substance; and I could only observe in addition that it had no action on polarized light. If the fossils themselves are without any signs of deposited silica, so too are the surrounding strata; no mention is made of flint, chert, or silicified shells occurring in them in any descriptions which I have read. This, then, would certainly be a difficulty in the way of our interpretation, were it not for the exceptional character of the Faringdon and Upware beds; considering that these are deposits of sometimes loose, sometimes consolidated gravel, subject, in all probability, to current-action in a shallow sea during deposition, and to the free drainage of percolating waters subsequently, one could scarcely expect to find the silica from dissolved organisms retained in their immediate vicinity and deposited in the same way as it is in close fine-grained deposits of chalk and limestone.

Thus the mineralogical argument cannot, in this case, be said to favour either side, and we are left to depend on structural character alone. This to me indicates a far closer alliance with siliceous than calcareous sponges; and I wait with some expectancy for Oscar Schmidt's descriptions of the sponges brought home by the 'Challenger,' in the hope that new forms will be found amongst them to obliterate the only wide difference which now distinguishes *Catagma* from *Plectronella*.

It is not necessary to stay now to describe the outward form and general characters of *Catagma*; it is sufficient to refer to Sharpe's paper on the Faringdon sponges, and to indicate those forms which should be placed in this genus. They are as follows:—

Catagma peziza (Manon, Sharpe);
C. macroporus (Manon, Sharpe);
C. porcatum (Manon, Sharpe);
C. faringdonense (Manon, Sharpe).

In the family of the Catagmida must be included *Tragos faringdonensis* and *Scyphia foraminosa*.

I cannot conclude, however, without remarking upon the fact that Professor Zittel not only assigns the fibrous sponges with multiradiate spicules to the Calcispongia, but also the genus *Pharetrospongia*, in which none but uniaxial spicules exist. Now, whatever uncertainty exists about the Faringdon and Upware sponges (and I admit a great deal), there is, I am confident, none here. The proofs as to the nature of *Pharetrospongia* are, I believe, perfect; and should the Faringdon sponges eventually turn out to be genuine Calcisponges, I do not see how that can for a moment affect the position of *Pharetrospongia.*

Its structure differs in no important respect, except in the absence of flesh-spicules, which fossilization would inevitably destroy, from that of a recent siliceous sponge (*Pharetronema*, Sollas) which I have now before me awaiting description. Both are exactly similar in the size and shape of their spicular elements, in the arrangement of these spicules in a fibrous manner, in the thickness and character of the sponge-wall, in the form of the fibrous skeleton, and, finally, in the absence of obvious pores, oscules, and excretory canals. Were the two to be found together in the fossil state it would be difficult to distinguish one from the other, except by a very slight difference in external form. While this exact agreement exists between *Pharetrospongia* and a modern siliceous fibrous sponge (and similar sponges are amongst the commonest of our existing seas), there is no resemblance, but the most absolute difference, between it and any known form of the Calcispongia. Furthermore, we can fortunately, in this instance, adduce the mineral state of the sponge in support of the morphological argument, since the silica removed from its calcitized spicules has been deposited in the infilling material of its meshwork, and many, a great many, of its spicules retain their original siliceous composition.

So seldom does a calcareous organism in the Cambridge Greensand become silicified, and so constantly does *Pharetrospongia* possess both siliceous spicules and a silicified matrix, that one cannot regard the presence of the silica as due to its subsequent introduction. The manner of its occurrence and the perfect form of the spicules, which are still siliceous, leave no doubt in my mind, independently of the morphological structure of the sponge, that the original composition of these Cambridge sponges was siliceous and not calcareous.

With regard to *Pharetrospongia*, then, we have to take nothing upon trust, to make no assumptions, to imagine nothing; the evidence is as perfect in its separate links, and as complete in the union of these links, as it is in the nature of palæontological evidence to be.

Bristol Museum,
Sept. 30, 1878.

EXPLANATION OF PLATE XIV.

(Structure of *Catagma*.)

Fig. 1. Transverse sections of simple spicules of the skeletal fibre. (× 435.)
Figs. 2–5. Variously curved simple spicules, seen longitudinally. (× 435.)
Fig. 6. Quadriradiate spicule showing three arms lying in the plane of the section, and a circular cut surface from which the fourth arm has been removed. (× 315.)
Fig. 7. Triradiate form with a part cut away at *a*. (× 315.)
Fig. 8. Quadriradiate spicule, not fully exposed, but suggestive of a *Stelletta* spicule. (× 315.)
Fig. 9. Transverse sections of multiradiate spicules, exhibited at the place where the fibre curves at right angles out of the plane of the section. *a a*, edge of the fibre where cut across at the bend. (× 315.)
Fig. 10. Irregular form of spicule, terminating abruptly against the edge of the fibre *a a*. (× 315.)
Fig. 11. Irregular quadriradiate spicule. (× 435.)
Fig. 12. Quadriradiate spicule with bifurcated rays. (× 315.)
Fig. 13. Simple quadriradiate spicule, resembling in form one of the spicules of *Pachastrella abyssi*. (× 315.)
Fig. 14. Triradiate arms showing a cut surface at *a*. (× 315.)
Fig. 15. Curved terminal part of a spicule, ending abruptly against the edge (*a a*) of its fibre, through which it probably originally projected. (× 315.)
Fig. 16. Large, irregular quadriradiate. *a a*, edge of fibre in which it lies imbedded. (× 140.)
Fig. 17. Simple quadriradiate, showing all four arms. (× 315.)
Fig. 18. An irregular form of quadriradiate, one arm closely resembling one of the curved simple spicules. (× 435)
Fig. 19. Quinqueradiate spicule. (× 435.)
Fig. 20. Fibre (*a a a*) near the exterior of the sponge, with included multiradiates, some having the shaft directed inwards and the rays outward. (× 435.)
Fig. 21. Edge of a fibre showing an echinating quadriradiate seated close to the surface of the fibre, with one ray projecting outside it into the bordering granular deposit. (× 140.)
Fig. 22. Usual position of the echinating multiradiate in the fibre. *a a*, surface; *b b*, centre of the fibre; *c c*, transverse sections of similar multiradiates; *d*, projecting ray of echinating spicule; *e e*, simple spicules lying longitudinally in the fibre and crossing the echinating ray transversely. (× 435.)

XXXIX.—*On two new Species of Amphipodous Crustaceans.* By the Rev. T. R. R. Stebbing, M.A.

[Plate XV.]

Amphilochus Sabrinæ, n. sp.

The upper antennæ have the three joints of the peduncle short, subequal in length, the first two stout, the third very slight. The flagellum, of six articulations, is tapering, its first articulation being about as thick as the preceding joint of the peduncle. The second, third, fourth, and last articulations carry long pairs of olfactory filaments.

The fourth and fifth joints of the peduncle in the lower antennæ are long and slender, each being equal in length to the entire peduncle of the upper antennæ. The flagellum is of six articulations.

The eyes are of moderate dimensions, with a rounded oval form. The rostrum is bent down between the upper antennæ. The maxillipeds have a long four-jointed palp, the fourth joint being bright, sharp, and unguiform.

Between the first and second gnathopods it is difficult to detect any difference whatever, except in regard to the coxæ, those of the first pair being minute and almost obscured by the overlapping of their neighbours. The coxæ of the second pair are themselves of no great size, and are in their turn overlapped to a great extent by the large coxæ of the third pair of legs. In the first gnathopods the thigh is moderately long and slender, the knee small, the metacarpus but little longer than the knee, overlapping the wrist throughout almost its whole extent, and having its truncate distal extremity capped with three setæ. The wrist is longer than the hand, along which it is produced almost as far as the ill-defined palm; it bears some four or five spines along the margin. The hand is elongate, narrower at the junction with the wrist than at the commencement of the palm, which is bordered with four pairs of spines. All these spines, at about a third of their length from their origin, are abruptly narrow; the distal half is pectinate on both sides. On the margin of wrist and hand away from the palm there are two or three minute spines. The finger is curved, thin, and sharp, with a small denticle at the base of the nail.

The more or less triangular coxa of the second gnathopods has a single indent at its lower angle. The rest of the limb seems in all its details to resemble the first gnathopod. This remarkable similarity of the two pairs of limbs would suggest the inference that the specimen examined was a female, but that the development of the olfactory filaments on the upper antennæ rather points to its being of the other sex.

The third and fourth feet have the coxæ largely developed, with their lower edges serrated. The hinder margin of the fourth and largest coxa is produced backwards in a sort of lobe. The thighs of these pairs of feet are long, with spines along the front edge. In the three following pairs of feet the coxæ are small, the thighs large, ovate, very transparent, the metacarpus posteriorly decurrent; the wrist and hand, judging from the last leg, in which alone these parts remained, are thin and small, with a few spines on the anterior margin, the finger thin and curved, with a small hair at the root of the nail.

The first three pleon-segments are rather longer than the segments of the pereion. The first uropods have the peduncle long, and the branches about the same length as the peduncle. In the second uropods the peduncle is a good deal shorter, with branches to correspond; in the third the peduncle, which has minute close-set hairs on its upper edge, is as long as in the first, but the branches are shorter than in either of the other pairs. The telson is triangular, elongate, slightly concave above. There is a minute angle on either side, just before the sharp apex is reached.

The solitary specimen obtained was dredged off Tenby in a few fathoms depth. Its length is a twelfth of an inch.

Amphilochus concinna.

(*Callimerus acudigitata.*)

Dredging at Tenby having yielded me three specimens of *Amphilochus concinna* of various sizes and in more or less good condition, a careful examination of them enables me to add some details as to the structure of this species. The flagellum of the lower antennæ varies from three to five articulations. In the smallest specimen the tooth-like process, which in the others is so conspicuous a termination to the upper margin of the hand in each gnathopod, is scarcely at all developed; the palm is fringed with a row of short, very fine and even hairs, but without perceptible denticulation; the long produced process of the wrist in the second gnathopods ends in two short cilia, being otherwise quite smooth. In the larger specimens, however, this process ends in three good-sized cilia, besides having two or three on each of its lateral margins. The shorter process of the first gnathopods has several cilia at and about the distal end. In the hands of both gnathopods the palms are not only denticulate, but have a short fine hair in each denticulation; while the fingers, instead of having the inner margins smooth as in the female previously described ('Annals,' Dec. 1876), have them fringed with fine hairs, the row terminating at the base of the nail in a small but well-marked spine-like process.

The telson is lanceolate and boat-shaped. In all three specimens the last uropods were unfortunately missing; but the character of these may, I think, be safely taken from the description and figure of *Callimerus acudigitata*, given in this Magazine for December 1876, and again referred to in the number for January 1878. What in establishing that genus

I supposed to be the first gnathopod, I now, from examination of the new specimens of *Amphilochus concinna*, cannot doubt to be the palp of the maxilliped. Under this new light the other differences between *Callimerus* and *Amphilochus* seem to lose their value, and the genus and species must be cancelled. It is true that the supposed *Callimerus acudigitata* has the finger of the second gnathopod remarkably produced, and in that respect resembles *Amphilochus odontonyx* of A. Boeck, though it is without the spined upper antennæ of that species; but the prolonged finger may easily be a casual variation in an organ which undoubtedly varies in relative length according to the size and age of the individual owning it. The maxilliped-palp of *Amphilochus concinna* has the last articulation unguiform. In the specimen examined this articulation was, perhaps by accident, more stumpy in one palp than in the other, its companion. The three preceding articulations are unusually stout, those which were mistaken in the supposed *Callimerus* for hand and wrist being about equal in length, the preceding one having a greater length, though about the same thickness.

One other remark may be added. When the first gnathopod of *Amphilochus concinna* is turned through a certain angle, it wears almost exactly the appearance of the corresponding limb figured by Messrs. Bate and Westwood for *Amphilochus manudens*. Now Axel Boeck, in his 'Amphipoda Borealia et Arctica' (Prodromus), assigns hands identical in shape, though differing in size, to both gnathopods of this species. But there he differs from the founder of the species; and as the type is no longer to be found, it would be interesting to know what ought in justice, or in scientific etiquette, to be done in regard to the names. If we may assume, as Boeck appears to have done, that the first gnathopod of *A. manudens* was seen from a point of view which led to an inaccurate description of it, then my species *A. concinna* may be pretty certainly regarded as only a synonym. To Boeck's description of the nail of each gnathopod as smooth and destitute of teeth and spines must be added the note that this applies to the female only, and not to the male.

Podoceropsis intermedia, n. sp.

The first joint of the upper antennæ is thick, much shorter than the head; the second joint is a good deal longer than the first, but not half its thickness; it has five long cilia on the lower margin. The third joint is about the length of the first. There are ten articulations to the flagellum; the secondary flagellum in the specimen described was but a single articulation. The lower antennæ are set very far back, with the first two joints short, the third equalling their combined length; the fourth considerably longer, much thinner, distally thickest, curved and slightly ciliated; the fifth joint the longest, thin, straight, and ciliated; the flagellum of ten articulations. The peduncle in the lower antennæ nearly or quite equals in length peduncle and flagellum together of the upper.

The head is produced into a sharp point, between the upper and lower antennæ; this angle is occupied by the oblique oval eyes. The mandibles are armed with two strong spine-like teeth, followed by four spines. The palp is long, composed of a short basal joint and two others much longer, subequal to one another, the last truncate and ciliated at the end. The palp of the maxillipeds ends in an unguiform joint, the penultimate joint being short, distally thickened, and the antepenultimate oval, very long, ciliated round the lower margin.

Owing to the extreme transparency of the animal, especially after mounting, the lines of demarcation of the coxæ were difficult to make out with certainty. The coxa of the second segment, however, is very conspicuously larger than any of the others, which are all small and shallow. The first gnathopods have the thighs slender, a little curved and distally widened, the knee small, the metacarpus a little larger and produced into a point, the wrist somewhat longer than the hand and as long as the thigh, for most of its length parallel-sided, the lower margin carrying six tufts of cilia springing from slight indentations; the hand has the upper margin curved, with cilia at intervals, the lower margin also curved and deeply indented, carrying four large spines interspaced with long cilia; the palm is microscopically crenulate. The finger is nearly as long as the hand, thick throughout nearly its whole length, but tipped with a small nail. The second gnathopods resemble the first as far as the wrist; but this joint is much broader without being quite so long; it has both margins curved, the lower tufted; the hand is much longer and centrally a good deal broader than the wrist, with the upper margin curved, the lower straight and tufted with cilia; the palm is sinuous, with a rounded central process, and near the lower angle a movable tooth-like spine. The massive finger closes down just within the straight lower margin, and is in shape like that of the first gnathopods. In the third and fourth legs the hand is thin, not longer than the metacarpus, the nail short. In the last three pairs the thighs are somewhat broader than in the preceding limbs, and are narrowed distally. In the last legs the hand is long and thin, the nail much shorter.

The first three segments of the pleon are infero-posteriorly rounded, with edges smooth, except that the first has one small indent; the pleopoda of these segments have bulky peduncles with small rami. Of the uropoda the first pair have long peduncles, carrying two spines on the upper margin and one distally below; the outer branch ends in two small spines, the inner and longer branch in one long spine attended by two little ones. The second uropods are similar, except that the peduncle is shorter and without spines; the third have the peduncle still shorter, and short rami, which except in length resemble those of the other pairs.

The telson is tubular, its upper surface a little concave, with a pair of slightly curved spines standing apart on the distal end.

It seems to come within the unhappily named subfamily of Microdeutopinæ (Boeck), which includes genera that have the second gnathopods larger than the first, as well as those that have the first larger than the second. It comes near to the genera *Gammaropsis* (Lilljeborg) = *Eurystheus* (Sp. Bate), and *Podoceropsis* (A. Boeck) = *Nænia* (Sp. Bate); and in this latter I venture to include it, although it has a secondary flagellum, contrary to a generic character assigned by Boeck to *Podoceropsis*, and the antennæ are not subequal, as required by one of Mr. Spence Bate's generic characters of *Nænia*. But the relative lengths of antennæ vary with age, sex, and size of specimen in many cases, and the absence of a secondary flagellum cannot be depended on. This latter is given as one of the generic distinctions between *Dryope* (Bate) and *Unciola* (Say); but, after all, *Dryope crenatipalmata*, which is plentiful at Tenby, undoubtedly possesses the secondary appendage in question; and Fritz Müller, in his 'Facts for Darwin' (translation by Dallas, p. 11), names several genera in which he has found it, though its presence in them had been previously undetected.

The inconvenience of the needless multiplication of genera is illustrated by the present species, which has claims on more than one, and ought perhaps on the present system to carry its peculiar second coxæ into a new genus of its own, so making a third in a trio which might far better be grouped under a single generic name. I venture to hope that whoever nexs rearranges the Amphipoda will group together *Microdeutoput* (Costa), *Aora* (Kröyer), *Autonoë* (Bruzelius), *Stimpsonia* (Bate) into one genus, and *Gammaropsis* and *Podoceropsis* into another.

EXPLANATION OF PLATE XV.

Fig. 1. *Amphilochus Sabrinæ.* 1 *a*, antennæ; 1 *b*, maxillipeds; 1 *c*, telson; 1 *d*, first gnathopod; 1 *e*, spines of wrist and hand, much magnified; 1 *f*, coxal plate of second gnathopod; 1 *g*, second gnathopod.

Fig. 2. Palps of maxillipeds of *Amphilochus concinna.* 2 *a*, second gnathopod of a small specimen; 2 *b*, second gnathopod of large specimen; 2 *c*, telson of ditto; 2 *d*, telson of small specimen.

Fig. 3. *Podoceropsis intermedia.* 3 *a*, mandible; 3 *b*, maxilliped; 3 *c*, end of pleon, much magnified; 3 *d*, first gnathopod, with enlarged view of palm; 3 *e*, second gnathopod; 3 *f*, enlarged view of palm and finger of ditto.

XL.—*Descriptions of Longicorn Coleoptera.* By Francis P. Pascoe, F.L.S. &c.

CERAMBYCIDÆ.

Helymæus signaticollis.
—— pedestris.

Temnosternus apicalis.

LAMIIDÆ.

Myagrus, n. g.
—— Hynesii.
Neanthes, n. g., for Monochamus curialis.
Meton fasciatus.
Agelasta mediifusca.
Peribasis princeps.
Euthyastus myrrhatus.
Pycnopsis variolosa.
—— miliaris.
—— rubricata.
Ceroplesis aspersa.
Ælara variolosa.
Xynenon larvatus.
Mispila anguralis.
Hoplistocerus eximius.
Hydraschema virgatum.

Helymæus signaticollis.

H. rufo-fulvus, supra confertissime punctatus; antennis, prothoracis medio, pedibusque (femorum basi excepta) nigris; tertia parte apicali elytrorum chalybeata. Long. 8 lin.

Hab. Yemen (Arabia).

In coloration quite different from its congeners; antennæ much shorter than the body, the eighth to the tenth joints broadly triangular, the last subovate, pointed; head entirely fulvous; prothorax very closely punctured, black except at the sides; scutellum with a raised amber-coloured border; elytra finely punctate, two slightly raised longitudinal lines on each, the posterior third a dark steel-blue; legs black, except the base of the femora; posterior tibiæ slightly curved; body beneath fulvous.

Helymæus pedestris.

H. confertissime punctatus, haud nitidus; capite, prothorace, antennis (articulis duobus basalibus exceptis), scutello, tarsisque nigris; elytris cyaneis; corpore infra femoribusque luteis. Long. 6 lin.

Hab. Yemen.

Closely punctured above, not shining; head, prothorax, and scutellum black; elytra dark blue; body beneath, femora, and base of the tibiæ fulvous; the rest of the tibiæ and tarsi black; antennæ black, the two basal joints fulvous, the seventh to the tenth very broadly triangular, the last deeply emarginate on each side towards the apex; hind tibiæ slightly curved. Allied to *H. notaticollis*, but differently coloured. All the species of this genus have hitherto been confined to South Africa.

Temnosternus apicalis.

T. dense griseo-pubescens; prothoracis lateribus, humeris, apicibusque elytrorum læte fuscis; elytris costa unica, postice obsoleta, instructis. Long. $4\frac{3}{4}$ lin.

Hab. Rockhampton (Queensland).

The smallest of the *Temnosterni*, and allied to *T. vitulus*, but proportionally narrower, the elytral costa less distinct, &c. Closely covered above with a greyish pile, a well-marked stripe on each side of the prothorax, and extending to the shoulders and the apex of the elytra, a rich brown; a small, well-marked tubercle on each side well behind the middle; elytra depressed, irregularly punctured, the costa disappearing towards the apex; antennæ not so long as the body, obscurely annulated with greyish, the third and fourth joints nearly equal in length; body beneath glossy brown, the pubescence confined to the sides.

Myagrus.

Caput parvum; tuberibus antenniferis validis, approximatis; antennæ corpore duplo longiores, articulo tertio quartoque æqualibus. *Oculi* magni, grosse granulati. *Prothorax* lateribus tuberculato-spinosis. *Elytra* breviuscula, apice rotundata. *Mesosternum* elevatum, antice productum. *Pedes* antici paulo longiores.

This is a *Monochamus*-form, the character of the mesosternum, however, bringing it nearer *Diochares* than to *Monochamus* proper. From *Diochares* the genus is essentially differentiated by its strong antennary tubers, separated at the base by a narrow groove, and approximated above. The only example I have seen was taken by G. Lewis Hynes, Esq., of the Bombay Mint, and kindly presented to me by Dr. Power.

Myagrus Hynesii.

M. breviusculus, castaneus, pube rufo-brunnea, maculatim albo-varia, vestitus; antennis subannulatis. Long. 6 lin.

Hab. Bombay.

Chestnut, covered with a reddish-brown pile spotted and blotched with white, the latter colour on the prothorax confined to the sides; on the elytra there are a number of spots, uniting more or less to form three patches, *i. e.* one on the shoulder, the second on the middle, and the third towards the apex; underside and legs with a whitish pile; antennæ brownish, the outer joints paler at the base; prothorax slightly transverse, the tubercular spine equidistant from the apex and the base; elytra rather short and somewhat depressed.

NEANTHES.

Characteres fere ut in *Monochamo*, sed articulus basalis antennarum obsolete cicatricosus. *Oculi* parvi. *Tubera antennifera* divergentia.

The type of this genus is *Monochamus curialis*; but as Lacordaire has based the classification of his "Section B" on the characters offered by the cicatrix, *i. e.* open or closed, and in the latter case often obsolete, it is necessary to have another genus for its reception. To none of his groups, however, is this genus allied, and I think it must be taken as exceptional and placed near *Monochamus.* The cicatrix is marked by a short and delicate carina, and is pubescent like the rest of the joint. The species is one of Fortune's finds in North China; it is closely covered by a rich brown silky pile, the anterior two thirds of the elytra inclining to greyish white. *M. luridus*, having the same habitat, might be placed in *Melanauster*; but the mesosternum is but slightly tuberculate. Its specific name was used in the less usual sense of "black and blue."

Meton fasciatus.

M. piceus, pube variegatim fuscescente griseaque vestitus; prothorace in medio tuberculato-gibboso, ad latera granulato; elytris apicem versus fascia transversa irregulari subalbida notatis. Long. 7 lin.

Hab. Port Bowen.

Pitchy, densely covered with a variegated pile, in which greyish or yellowish grey with shades of brown predominate; prothorax with a longitudinal fulvous-grey stripe, in which posteriorly is a small tubercular gibbosity, on the sides anteriorly a few small glossy granules; elytra not quite as broad again as the base of the prothorax, spotted with tufts of short dark brown hairs, towards the apex a transverse, whitish, irregular, somewhat zigzag band; antennæ pubescent, the first joint black.

Nearly allied to *M. granulicollis* from the Aru Islands, but larger and proportionally more robust, the band on the elytra transverse, not oblique, and with the peculiar little gibbosity on the prothorax.

Agelasta mediifusca.

A. grisescens, fusco-variegata; antennis annulatis; elytris, basi apiceque exceptis, fuscis, maculis plurimis dispersis; tibiis anticis apicem versus incrassatis, extus pilosis. Long. 6 lin.

Hab. Andaman Isles.

Quite unlike any other *Agelasta*, but with the anterior tibiæ thickened and fringed with short hairs as in *A. callizona.* Pubescence greyish varied with brown; on the head and prothorax the brown occurs in confluent spots, the middle of the latter being somewhat bare of pubescence; on the elytra the brown forms a broad band finely speckled with grey; the tips of the tibiæ and first two joints of the tarsi are black; underpart irregularly greyish; antennæ about the length of the body, the basal joint spotted, the second entirely greyish, and the third and sixth greyish only at the base, the rest dark brown inclining to black.

Peribasis princeps.

P. obovatus, niger; prothorace sparse fulvo-pubescente; elytris pube interrupta læte æruginosis, regione scutellari maculis fulvis. Long. ♀ 13 lin.

Hab. Labuan.

Obovate, black; head with five determinate patches of fulvous pile, viz. two frontal, one on each cheek, and one on the vertex; antennæ black, about as long as the body in the female; prothorax speckled with fulvous, the lateral spine small; scutellum fulvous; elytra with a projecting lobe at the base on each side of the scutellum, the sutural region with fulvous spots, the sides rich bluish green, more or less speckled with black; underparts and femora with a rather dense fulvous pile, except the middle of the abdominal segments; tibiæ and tarsi with a sparse whitish pubescence.

This handsome species differs structurally from its congeners in the lobed base of the elytra, as in *Otarionomus*; in other respects it is a true *Peribasis.* I have seen no males; their antennæ will probably be twice the length of the body.

Euthyastus myrrhatus.

E. fuscus, pube condensata flavescente irregulariter maculatim notatus; elytris tenuiter punctatis, basi granulis parvis nitidis instructis. Long 8–9 lin.

Hab. Penang and Andaman Islands.

Rather shorter proportionally than *E. binotatus*, from which it will be readily distinguished by its differently arranged pubescence. Above brown, very slightly pubescent, except the condensed yellowish portions, which on the head and prothorax form four longitudinal stripes, the two middle being approximate or even confluent; the elytra are irregularly spotted, the spots being more or less united and not quite conformable on the two elytra; antennæ twice as long as the body, the third or fourth and the following joints more or less ashy at the base; scutellum semicircular; body beneath and legs chestnut-brown, sparsely pubescent.

Pycnopsis variolosa.

P. subovata, nigra, subnitida; elytris pube alba condensata in maculis minutis aspersa; scutello transverso, apice rotundato, integro. Long. $7\frac{1}{2}$ lin.

Hab. Ngami.

Black, slightly glossy; head finely punctured; prothorax transversely rugose, lateral tubercle well marked; scutellum transverse, the apex rounded and entire; elytra irregularly punctured, the punctures much larger at the base, the interspaces with small white but conspicuous spots formed of tufts of short hairs (sterna tufted in like manner); legs and antennæ finely pubescent, the latter with the third and fourth joints nearly equal in length.

Pycnopsis miliaris.

P. subovata, fusco-nigra, opaca; elytris pube alba condensata in maculis minutis aspersa; scutello minus transverso, apice bilobo. Long. 9 lin.

Hab. Angola.

Brownish black, nearly opaque; head less finely punctured; prothorax transversely rugose, lateral tubercle well marked; scutellum moderately transverse, the apex bilobed; elytra nearly as in the preceding, but broader and less convex, the tufts smaller and accompanied by others still more minute, composed of three or four hairs only; legs rather coarsely pubescent; the anterior tarsi in the male very broad; antennæ with the third and fourth joints nearly equal in length.

Broader and more depressed elytra, and proportionally shorter, than in the preceding.

Pycnopsis rubricata.

P. longius obovata, nigra, pube rubro-fusca vestita; prothorace fortiter transverso; elytris fascia determinata rubra, ante medium sita, ornatis. Long. 12 lin.

Hab. Grahamstown (Cape).

Oblong-ovate, black, covered with a dull reddish-brown pile; prothorax strongly transverse, the middle anteriorly striated; elytra coarsely punctured at the base, a determinate dull red band placed well before the middle, another less distinct at the tip, and between them another, but largely interrupted at the suture; antennæ black, the third joint conspicuously longer than the fourth.

This species is more nearly allied to *P. brachyptera*, but it is duller and otherwise different in coloration, with much longer elytra, the prothorax more transverse, &c.

Ceroplesis aspersa.

C. nigra, opaca, elytris maculis numerosis rufis subtransversim dispositis. Long. 14 lin.

Hab. Usambara (East Africa).

Opaque black, except a slight tinge of bronze at the base of the elytra, where they are also very distinctly punctured; but the punctures are much smaller posteriorly, each bearing a minute white seta; the intervals are apparently naked, but under a strong lens a very delicate pubescence is visible; unlike its congeners the two or three normal red bands are replaced by a number of mostly somewhat transverse reddish spots, by no means corresponding on the two elytra; underpart rather glossy, with a scattered pubescence; antennæ and legs black.

Ælara variolosa.

Æ. subangustata, parallela, pallide brunnea et dense tomentosa; elytris punctis impressis nitide nigris sat sparse sed conspicue notatis, apicibus subtruncatis, singulis dentato-productis. Long. ♂ 7, ♀ 11 lin.

Hab. Andaman Isles.

The contour and well-marked glossy black punctures will readily distinguish this species from its congeners. The antennæ are not quite so long as the body, the joints are ashy mostly only at the base; the head with a few impressed punctures between the eyes; prothorax rather sparsely punctured, irregular at the sides, but without a tubercle, the centre with two longitudinal impressions; scutellum slightly transverse, the sides parallel; elytra with much larger punctures than those on the prothorax, and small punctures in the intervals, the sides anteriorly with a large indistinct blotch, the apex of each produced on each side into a well-marked tooth-like tubercle; underparts paler, slightly spotted.

Xynenon larvatus.

X. pallide griseo-pubescens, supra fusco nigroque variegatus; antennis articulo quinto nigro, reliquis (octavo excepto) subnigrescentibus. Long. $6\frac{1}{2}$–7 lin.

Hab. Andaman Isles.

Head very transverse in front; antennæ about two thirds as long as the body, rather stoutish, but slighter towards the tip, fifth joint entirely black, the rest darkish (variable); prothorax somewhat transverse, the lateral tubercle very small, two narrow brown central stripes with paler stripes at the sides; elytra finely and irregularly punctured anteriorly, two black dashes on each at the base, and a roundish black patch on each side behind the middle, its posterior margin very irregular; underparts and legs uniformly greyish.

Nearly the same form as *X. Bondii*, but the elytra more convex posteriorly, and, as a specific character, differing remarkably from that species in that the intermediate tibiæ are emarginate externally and pilose.

Mispila auguralis.

M. leviter pubescens, fusca, nigro subvariegata, maculis parvis niveis ornata; antennis (articulis duobus basalibus exceptis) nigris, tertio et sequentibus basi griseis. Long. 7 lin.

Hab. Andaman Islands.

This species wants the curvilinear white line of *M. venosa* and *M. curvilinea*; but it has the annulated antennæ of the former. On the prothorax the black pubescence forms a sort of ring, in the middle of which are two small crescentic spots; the elytra, gradually narrowing from the shoulders, are irregularly punctured at the base; a few dark spots, principally in the middle on each side, are approximated so as to look almost like a single patch; and this is delicately picked out at the margin with a few white sublinear spots; a similar patch occurs also at the base and apex. Antennæ of the male more than half as long again as the body, fringed beneath.

Hoplistocerus eximius.

H. glaber, capite prothoraceque nitido viridi-aureis; elytris læte viridibus, haud nitidis, sutura violacea; abdomine femoribusque, anticis exceptis, nitide luteis. Long. 4 lin.

Hab. Bahia.

Smooth and glossy, except the elytra; head and prothorax rich greenish gold, the latter and the vertex transversely striate; antennæ and legs, except the posterior and intermediate femora, glossy violet-black; scutellum transverse, green; elytra pure dark green, uniformly punctured, the suture violet; sterna golden green; abdomen and femora, except the anterior, glossy reddish yellow.

In coloration very distinct, according to descriptions, from *H. gloriosus*, Bates, and *H. refulgens*, Blanch.

Hydraschema virgatum.

H. elongatum, sublineare, fuscum, pube albida, in vittis condensata, vestitum; antennarum articulo quarto cæteris longiore, primo excepto, sequentibus gradatim brevioribus. Long. $6\frac{1}{2}$ lin.

Hab. Brazil.

Sublinear, elongate, dark brown, covered with a whitish pile, which is condensed on the centre and sides of the prothorax into very determinate stripes; on the elytra, along the suture the pile forms an evident stripe, spreading out towards the apex, and sending off a branch which passes obliquely to the shoulders, each elytron tapering away to a sharp point; hind legs scarcely extending to the last abdominal segment; antennæ nearly black.

Hydraschema fabulosum, as M. Thomson has described it, differs, *inter alia*, in having all the joints of the antennæ, the second excepted, of equal length, and in having certain yellow spots, &c.

XLI.—*Notes on some British Land and Freshwater Shells.* By J. Gwyn Jeffreys, LL.D., F.R.S.

My attention has of late been almost exclusively directed to marine conchology; but a correspondence which I have now had with Dr. Baudon of Mouy and Dr. Westerlund of Ronneby induces me to offer a few observations on two or three species of British land and freshwater shells.

Dr. Baudon has most kindly sent me specimens of most o the French species and varieties of *Succinea* which he so admirably described and figured in the 'Journal de Conchyliologie' for last year. It is a most laborious and exhaustive monograph. This experienced author is a true man of science; and I feel sure that he will not object to the critical remarks which I venture to make from a point of view different from his. I am aware and glad that he does not follow the example of certain of his countrymen in fabricating what they call "new" species out of every trivial variety and local form. No individual specimen can be precisely like another; and considerable allowance ought to be made for a difference of conditions. The result of my investigations during a period of at least half a century has been rather to reduce than increase the number of species represented by abundant or widely distributed forms. Now this is remarkably the case with some land and freshwater Mollusca, including *Succinea* and *Lymnæa*, which are so prolific and inhabit watery places with easy and various means of migration or transport.

Having carefully examined Dr. Baudon's specimens of reputed species of French *Succineæ*, and compared them with specimens in my own collection of British shells, I would assign those species as follows:—

S. parvula, L. Pascal, = *S. elegans*, Risso; var. *ochracea*, Betta.

S. Baudoni, H. Drouët, = *S. putris*, Linné; dwarf form.

S. acrambleia, J. Mabille, = *S. putris*; var. *solidula*, Jeffreys.

S. Pfeifferi, Rossmässler, = *S. elegans*; var.

S. arenaria, Bouchard, = *S. oblonga*, Draparnaud; var.

S. humilis, H. Drouët, = *S. oblonga*; var. (ex exemplis mihi ab auctore missis).

S. Crosseana (*Crossiana*), Baudon, = *S. oblonga*; var.

S. breviuscula, Baudon, = *S. oblonga*; var.

With respect, however, to *S. virescens* of Morelet, which Baudon has apparently described under Morelet's name of *S. debilis*, I believe it is distinct from any of the three species which I have acknowledged as British, viz. *putris*, *elegans*, and *oblonga*. It should therefore be added to our native fauna. This is my variety *vitrea* of *S. putris*, 'British Conchology,' vol. i. p. 152. I lately found a specimen at St. Alban's, with *S. putris*; but unfortunately I had no time to examine the animal, further than by noticing that it seemed to be of a darker hue than that of *S. putris* or *S. elegans*. Mr. Henry Groves has obligingly sent me a specimen of the shell, which he had collected at Mitcham in Surrey. The other localities which I have recorded are Carmarthenshire and Grassmere

(*J. G. J.*), and Cork (*Humphreys*). The shell is extremely thin and finely striated lengthwise; the spire is very small, the last whorl disproportionately large, and the mouth more open and expanded than in any other European species. I regard it as the *S. virescens* of Morelet (Moll. Port. p. 53, pl. v. f. 3, 1845), and not as his *S. debilis* (Pfeiffer, Mon. Helic. Viv. p. 811, 1859), which Baudon names it. The last-named author says (Journ. Conch. 3e sér. t. xvii. p. 181) as to *S. debilis*, Morelet, "Synonymie: 1845. Morelet, Moll. de Portugal, n. 63, p. 52, pl. v. f. 2." But in Morelet's work, now before me, no such species as *debilis* is described, figured, or mentioned. In Pfeiffer's monograph *S. debilis*, Morelet, is fully described, and numbered "63," from Cuming's collection, with the habitat "Algeria." There consequently appears to have been a slight mistake in Baudon's reference to Morelet. I have now examined the types of *S. debilis*, Morelet (two specimens), in the British Museum; and I believe that so-called species is one of the numerous varieties of *S. elegans* (or *Pfeifferi*), viz. *brevispirata*, Baudon, and not the same species as *S. virescens*, Morelet, nor my variety *vitrea* of *S. putris*. Baudon's description of the animal of his *S. debilis* differs from Morelet's description of the animal of *S. virescens* chiefly in colour, the former being "gris jaunâtre," and the latter "brun roussâtre"; although I do not attach much importance to that character. Not merely does the intensity of colour vary in many specimens of the same species of land shell, but also the arrangement of the colours. This is very noticeable in *Helix rufescens*, out of which a dozen species might be made if colour were a specific character; and a similar difference is observable in the shell. *S. putris*, *S. elegans*, and *S. oblonga* may readily be known by their "animals" or soft parts, as well as by their shells. It is quite impossible thus to distinguish *S. elegans* from *S. Pfeifferi*, or the *S. gracilis* of Alder, all of which are connected by intermediate gradations.

Helix hispida, L.
Helix concinna, Jeffr.

As one of the distinctive characters of these two species is the shape of the umbilicus in the shell, I cannot help remarking that Dr. Westerlund, in his excellent work, 'Fauna Europæa Molluscorum Extramarinorum Prodromus,' fasc. i. p. 49 (1876), describes *H. hispida* as "sat late umbilicata," var. *nana*, Jeffr., as "umbilico latiore," var. *depilata*, C. Pfeiffer, as "apertius umbilicata," and var. *concinna*, Jeffr., as "late umbilicata." I have, on the contrary, described *H.*

hispida as having the umbilicus "small and narrow, but deep;" as to my variety *nana*, I said nothing about the umbilicus, which is the same as in the typical form; C. Pfeiffer describes the umbilicus in his *H. depilata* as "eng und tief;" and I described the umbilicus in my *H. concinna* as "rather broad, open, and deep." I add no further comment.

Helix virgata, Da Costa (1778).

Westerlund calls this species *H. variabilis*, Draparnaud (1801), and cites as a synonym *H. virgata*, Montagu (1803). But Da Costa's work was twenty-three years older than that of Draparnaud. See Brit. Conch. i. pp. 210, 213.

Vertigo Moulinsiana, Dupuy.

After I had published this species as British (Brit. Conch. i. p. 255) Westerlund described an allied species as *V. modesta*, and since as *V.* (*Pupa*) *Lilljeborgi*; and he considered my species to be the same as his, and not Dupuy's species. We have now exchanged specimens; and I am satisfied that he is right. My Irish species must therefore take his name of *Lilljeborgi*. But the species which I noticed in the Supplement to my work (v. p. 160), and in the 'Annals' for May 1877, p. 432, as *V. Moulinsiana* (in consequence of Mr. Groves's communication), is certainly Dupuy's species, and is another addition to our list. A second British locality for this species in a living state has been likewise discovered by Mr. Groves, in the neighbourhood of Hitchin; and he has most courteously shown me the spot and assisted me in collecting specimens. I subjoin a description of the animal.

Body smooth, shining: *colour*, above dark grey, with darker streaks arranged lengthwise; below of a much paler hue, and interspersed with numerous, irregular, microscopic black specks: *mantle* thickish, greyish-white, protruded like a short collar: *snout* hood-shaped, closely wrinkled across, in front gently rounded, or very slightly indented on each side so as to make that part trilobular: *mouth* small, triangular, placed underneath the snout in the middle: *tentacles* club-shaped, folding inwards, diverging at a right angle, having a faint tint of purple; there is not the least trace of a lower pair of tentacles: *eyes* roundish-oval, seated on the bulbs or points of the tentacles towards the front: *foot* thick, greyish-white, three or four times as long as broad, squarish or nearly truncated in front, and gradually narrowing behind to a blunt point; it is nearly the length of the shell; its texture appears to be parenchymatous; sole very flexible, especially at the edges: *pulmonary orifice* small.

On grasses in wet places, high up the stalk.

The shell of *V. Moulinsiana* is rather more swollen or barrel-shaped than that of *V. Lilljeborgi*; and the labial rib is much stouter; it agrees exactly with French and Danish specimens which I received from Dr. Baudon and the late Dr. Mörch as *V. Moulinsiana*, and with Swedish and Carinthian specimens sent me by Herr Poulsen and Dr. Westerlund as the *Pupa lævigata* of Kokeil. For other synonyms see 'Annals' above cited; and for other localities see Brit. Conch. i. p. 256, and v. p. 160.

Vertigo tumida, Westerlund (*Pupa*).

I am also indebted to Dr. Westerlund for this species, of which I find a specimen in my collection named *V. pusilla*, var. I am not sure that it is more than a dwarf variety or form of *V. pusilla*. The two specimens sent by Dr. Westerlund differ from each other in the number of teeth, one specimen having five and the other seven teeth. He describes *V. tumida* as "6-dentata," and *V. pusilla* as "6–8-dentata."

Vertigo angustior, Jeffr.

Miss Amy Warren has kindly sent me some living specimens, which she found among moss and *Jungermannia* at Ballina, Co. Mayo. I am thus enabled to confirm the description of the animal given in Brit. Conch. i. pp. 265, 266. The eyes are oval; and there is no rudiment of a lower pair of tentacles. The same lady had previously found this exquisite little shell at Bundoran, Co. Donegal.

Clausilia rugosa, Draparnaud.

So many continental conchologists have given me the credit of naming this common and widely spread species *C. nigricans*, that I should be glad to say a few words in explanation. In my "Synopsis of the Testaceous Pulmonobranchous Mollusca of Great Britain," which was read at a meeting of the Linnean Society of London in 1828, and published in their Transactions, I described (p. 351) *C. nigricans*, quoting *C. rugosa* of Draparnaud, *Helix perversa* of Müller, *Turbo perversus* of Pennant and Donovan, *T. bidens* of Montagu, and *T. nigricans* of Pulteney (2nd edition) and of Maton and Rackett. I then assumed that, because the *Helix perversa* of Müller and the *Turbo perversus* of Pennant and Donovan were the same as Linné's species (*T. perversus*), and belonged also to the genus *Clausilia*, and because the *T. bidens* of Montagu was not the Linnean species of the same name, Pulteney's name of *nigricans* should be adopted as being older than that of Draparnaud. But at that time I had no opportunity of consulting the original edition of Pulteney, which appeared in 1799; and I concluded that the second edition (1813) recapitulated the specific names given in the original edition. I subsequently found out my mistake. The present species is the *Turbo perversus* of Pulteney, 1799; and that name is prior to *rugosa*. *T. perversus*, Linné, is the type of the genus *Balia*. The specific name *nigricans* was first published by Maton and Rackett in 1804; Draparnaud's name *rugosa* dates from 1801. See Brit. Conch. i. pp. 278 and 280.

Valvata piscinalis, Müller.

Mr. Groves has generously presented me with a reversed or sinistrorsal specimen from Sunbury. This kind of monstrosity occurs in probably every species of turbinated or spiral univalves, as well as in some bivalves.

XLII.—" *On the* Willemoesia *Group of Crustacea.*" By the Rev. A. M. Norman.

Mr. Spence Bate has a paper on a very interesting series of new Crustacea, from the 'Challenger' expedition, in this month's 'Annals.' I do not see my way at present, however, to acquiescing in his conclusions, and therefore venture to ask him to give us some further information.

1. Are his genera *Pentacheles* and *Willemoesia* any thing more than the *other sex* of *Polycheles*? Has not my friend *mistaken sexual for generic characters*? Has he male and female of any *Polycheles* or any *Pentacheles*? and if so, will he let us know how these sexes are distinguished? Judging from his descriptions, I should say that *Polycheles Helleri* and *Pentacheles euthrix* are the two sexes of the same species. Can he prove that they are not?

Two Crustacea dredged by the 'Porcupine' expedition of 1870 off the Spanish coast are before me. I consider them male and female of *Polycheles typhlops*, Heller; but the one is, according to Bate, a member of another genus (*Pentacheles*) differing from *Polycheles* in having the last pereipods chelate, a deeper notch on each side of the front of the carapace, and slight diversity in the lateral and dorsal spiny adornments of the carapace *. These are the only two specimens I have seen; my conclusion that their difference is sexual *may* be wrong. Can Mr. Bate *prove* it to be so †?

2. The eyes. Eyes are things to see with. Has *Polycheles* such organs? Mr. Spence Bate objects to my friend Prof. Heller saying that the eyes are rudimentary: have lenses then been found? There will not be space in the 'Annals' of November to go into this matter, nor have I time to do so. It will suffice to say, that it were to be wished that Mr. Bate had lettered the figures of the plate to have made them more clear; I confess to difficulty in understanding the drawings. The organ he describes is clearly not the same as that which Heller speaks of when he writes, "Distinct eyes are not present, but on the bases of the peduncle of the inner antennæ one observes on both sides a small round black spot as an indication of an organ of sight."

3. Is *Polycheles* nearly related to *Alpheus*? I cannot find the slightest sign of such relationship. The mouth-organs, those important elements in the classification of the Crustacea, are wholly different; but the mandible of *Polycheles* is not unlike that of *Astacus*, with which genus *Polycheles* was compared by Heller. Mr. Bate mentions two points of resemblance to *Alpheus*: 1st, that the embryos of both have "large and distinctly pedunculated eyes," a character which, I take it, is not very rare among the embryos of the Macrurous Crustacea! 2nd, *Alpheus* is spoken of as in "its adult condition burrowing in the mud of the sea-bottom," and *Willemoesia*, "I believe, burrows in the soft mud of the deep-sea bottom. This is borne out by the contents of the stomach,

* Had Willemoes-Suhm been acquainted with the genus *Polycheles*, he would never have established the genus *Willemoesia*. No doubt Heller's work was not in the 'Challenger' library; but there must have been the 'Porcupine' Report of 1870; and had he looked there he would have found that I had recorded *Polycheles typhlops* as taken off the Spanish coast (Station 9), the *name* of which is peculiarly suggestive. Mr. Bate seems also to have overlooked the circumstance that *Polycheles typhlops* had been found in the Atlantic, as he only gives the Mediterranean as its habitat.

† There is another case, however, in which Mr. Bate persists against proof in maintaining a genus founded on mere sexual characters. In the 'Annals' of May he describes (vol. v. p. 411) a *Lestrigonus spinidorsalis*; but all other carcinologists are, I believe, agreed that *Lestrigonus* is simply the male of *Hyperia*; and I have myself paired the British species described by Bate and Westwood (see Brit.-Assoc. Report, 1868, p. 286). I may add that the second crustacean described in the May number (*Diastylis bimarginatus*, Bate) is my *Diastylis spinosa* (Brit.-Assoc. Report, 1868, p. 271), as will be obvious to any one comparing the descriptions.

which I found to be full of the remains of the structures found in the *Globigerina*-ooze." The statement that *Alpheus* burrows in the mud is new to me. Its structure seems eminently unfitted for burrowing; and I have watched the habits of *Alpheus megacheles* (Hailstone), of which I have found large numbers in rock-pools and among rocks in the Channel Islands, but never a specimen burrowing in the sand. Again, the whole structure of *Willemoesia*, compared with *Scyllarus* and other Crustacea of kindred form, seems to suggest that it is a swimmer and crawler, not a burrower; and it will be obvious to any one who knows what the bed of the Atlantic is like, that there is no need that *Willemoesia* should burrow in order to obtain possession of "structures found in the *Globigerina*-ooze."

4. The relationship to *Eryon*. The connexion of *Polycheles* with *Eryon* is very close. A glance at Dr. Woodward's admirable restoration of the Liassic *Eryon barrovensis*, M'Coy*, and a comparison of it with figures or specimens of the since-discovered *Polycheles*, are sufficient to indicate the very near and most striking relationship. The only differences visible are the supposed presence of distinct eyes, and the absence of a scale attached to the peduncle of the inner antennæ; add to these the fact that Quenstedt thought that he had observed palpi at the base of the gnathopods in *Eryon*, and we have the sum of the apparent differences between the two genera. Dr. Woodward has most kindly, in accordance with a request from me, examined both fossils and drawings of *Eryon* on the above points. In reply, I have received the following important notes from that excellent fossil carcinologist:—

"(1) I have not observed a palp at the base of the gnathopods in *Eryon*†.

"(2) The inner antennæ have no scale on the inner side; but the extremities of the maxillipeds, which are *round*, might easily be mistaken for a scale.

"(3) The eye in my restoration (of *E. barrovensis*) should have been *less pronounced*, as, although I have little doubt of its position, it has never been positively determined. I *think* it can be seen on one side of Mr. Brodie's specimen, and on both sides of *Eryon* (*Coleia*) *antiquus*, Brodp. sp. I cannot see the eyes in *Eryon crassichelis*, H. Woodw."

The only marked character, therefore, which is unques-

* Woodward, Quart. Journ. Geol. Soc. vol. xxii. 1866, pl. xxv. fig. 1.

† The organ which Quenstedt thought might be a palp of the gnathopods was probably one of the 2nd or 3rd maxillipeds out of its place. Both these in *Polycheles* are palpiform and might easily lead to the mistake.—A. M. N.

tionably substantiated to distinguish the Jurassic and Silurian genus *Eryon* from the recent *Polycheles* is that in the latter, but not in the former, the inner antennæ are furnished with a scale on the inner margin. This is a point to which attention has not been previously directed; but I think it affords sufficient ground for keeping the genera distinct.

With respect to the chelation (as in *Pentacheles*) of the last pereiopods in *Eryon*, Dr. Woodward writes to me:—"The hind foot seems to be simple, not chelate—as far as the specimens before me enable me to form an opinion, certainly. I thought I detected an indication of the last foot being chelate (*minutely so*) in a Solenhofen *Eryon*; but it might be due to fossilization."

XLIII.—*Studies on Fossil Sponges.*—II. *Lithistidæ.* By Karl Alfred Zittel.

[Continued from p. 341.]

Rhizomorina (*continued*).

Pomelia, Zitt.

(*Recent.*) Sponge from clavate to cylindrical, short-stalked, attached by a broad base. Vertex convex, with a pit-like depression, in which there are several small circular apertures of vertical tubes which traverse the sponge-body. Isolated pits of the same kind with tubular canals on the sides. Surface very regularly furnished with fine pores. Skeleton formed of short, curved, rather thick, branched corpuscles, covered all over with processes, arranged in trains, the forked ends of the branches being closely interwoven. Corpuscles at the surface of the same form as those of the interior, but no true surface-structures present in the specimen.

The genus, which is named after M. Pomel, is very nearly related in external appearance to various sponges from Oran referred by Pomel to *Jerea*, *Polyjerea*, *Marisca*, and *Jereopsis*, some of which probably approach this genus more nearly than the Cretaceous forms of *Jerea* and *Jereica*. The sponge described is from Florida, and was received from Prof. O. Schmidt under the name of *Corallistes? polydiscus*.

Jereica, Zitt.

Jerea p. p., auct.; *Polyjerea* p. p., auct.
Spumispongia p. p., Quenst.

Sponge simple or compound, cylindrical, top-shaped, clavate, pyriform, or obconical, shortly stalked, attached by a broad disciform foot. Vertex truncate or with a shallow pit, in which are the apertures of several round efferent tubes which vertically traverse the whole sponge-body. Surface uniformly covered with pores, from which capillary radial canals penetrate to the centre of the sponge. Skeleton composed of fine, radiciform, irregularly branched or simple siliceous corpuscles, elegantly filigreed by numerous longer and shorter side branches; they lie close together, and are united into radial trains by their processes. In some species (*J. punctata*) the radial canals are in vertical rows; the walls of these are formed by the interlaced branched ends of the corpuscles, the main stems of which form pillars uniting two neighbouring lamellæ.

This genus closely resembles *Jerea* outwardly; but the microstructure is quite different. In *Jerea* the skeletal elements are more or less regular quadriradiates of considerable size, which form a loose meshed texture. Externally *Jereica* differs from *Jerea* by the finer and more uniform pores of the surface, the absence of a branched base, and the very numerous radial canals.

The typical species are:—

*1. *Jerea polystoma*, Röm. Spong. xii. 5. Senonian, Ahlten.

*2. *Jerea tuberculata*, Röm. ib. xiii. 3. Senonian, Ahlten.

3. *Jerea punctata*, Goldf. lxv. 13. Senonian, Sutmerberg.
Spumispongia punctata, Quenst. Petr. cxxxiv. 10–12.

4. *Jerea sexplicata*, Röm. Spong. xii. 4. Senonian.

5. *Spumispongia alveare*, Quenst. Petr. cxxxiv. 20. Senonian, Ilsenburg.

Also probably *Jerea ocellata*, *oligostoma*, *tessellata*, and *mamillosa*, Röm., from the Cretaceous of Ilsenburg.

Very likely many of the sponges from the Miocene of Oran described by Pomel under the genera *Jerea*, *Jereopsis*, *Ischadia*, *Polyjerea*, and *Dichojerea* belong to *Jereica*.

Cœlocorypha, Zitt.

Scyphia p. p., *Siphonia* p. p., *Eudea* p. p., and *Siphonocœlia* p. p., F. A. Röm.
Spumispongia p. p., Quenst.

Sponge simple or compound, with a broad base, or cylindrical. Vertex convex, with a tubular stomachal cavity, which is sometimes shallow, sometimes more or less deep. Frequently radiating, branched, superficial furrows run from its upper margin. Sides uniformly covered with numerous pores, opening into fine radial canals. Skeleton composed of small irregularly branched corpuscles, covered with verruciform or spiny processes. Sometimes a part of the surface has an apparently smooth covering-layer, formed of young, densely interwoven skeletal corpuscles.

The genus differs from *Scytalia* by its narrower and shallower central cavity, its stouter gnarled corpuscles, and the absence of large radial canals. No isolated spicules observed.

a. Simple forms:—

1. *Siphonocœlia nidulifera*, Röm. Spong. xi. 3. Senonian.

*2. *Eudea crassa*, Röm. ib. x. 4. Senonian.

3. *Cœlocorypha subglobosa*, Zitt. Senonian.
Spumispongia punctata p. p., Quenst. Petr. cxxxiv. 9, 13–15.

4. *Chætetes cretaceus*, Trautsch. Bull. Mosc. 1877, vi. 5. Senonian.

5. *Scyphia acuta*, Röm. Spong. ii. 4. Senonian, Sutmerberg.

b. Compound forms:—

6. *Polycœlia familiaris*, Röm. Spong. xi. 10. Senonian, Sutmerberg.

*7. *Siphonia socialis*, Röm. Kr. ii. 5. Senonian, Sutmerberg.

Scytalia, Zitt.

Scyphia p. p., *Siphonocœlia* p. p., *Jerea* p. p., *Eudea* p. p., auct.
Tubulospongia p. p., Court.
? *Cladocalpia*, *Calpia* p. p., Pom.

Sponge elongate, cylindrical, rarely clavate, simple or branched, with a round, tubular central cavity, usually reaching nearly to the base, into which open numerous radial canals, becoming thinner outwards, and, frequently branching, form pore-like ostia at the surface. From the lower extremity of the central cavity perpendicular canals run into the narrow base. Skeleton of curved corpuscles, with pointed processes and somewhat branched ends; among these are sometimes scattered bacillar spicules and anchors with three and six prongs.

The forms placed here constitute a genus agreeing in external form with various siliceous and calcareous sponges of quite different microstructure. Fromentel gave the name of *Siphonocœlia* to all simple cylindrical fossil sponges with a round central tube; and this name has been generally accepted. But the two species cited by him in the 'Introduction à l'étude des Éponges fossiles' (*S. elegans*, Münst., and *S. compressa*, From.) do not belong to the Lithistidæ, any more than the other species subsequently described by him. Probably some of Courtiller's *Tubulospongiæ* belong to *Scytalia*.

All the species are Cretaceous.

*1. *Jerea turbinata*, Röm. Spong. xii. 1. Senonian, Ahlten.

*2. *Cnemidium pertusum*, Reuss, Kr. xvi. 7, 8, 11–14. Cenomanian.

3. *Spongia radiciformis*, Phill. Yorksh. i. 9. Senonian.

4. *Spongia terebrata*, Phill. ib. i. 10. Senonian.

5. *Spongia digitalis*, Röm. Spong. x. 10. Tourtia.

*6. *Ventriculites microporus*, Röm. ib. vii. 6. Senonian.

7. *Eudea annulata*, Röm. ib. xi. 2. Turonian.

8. *Epeudea nodosa*, Röm. ib. xiv. 3. Cenomanian.

9. *Spongites cylindripes*, Quenst. Petr. cxxxiii. 21, 22. *Cuvieri*-Pläner.

[? *Tubulospongia insignis*, *limbata*, *elongata*, *ficoidea*, *contorta*, *dendroidea*, Court. (non *T. tuber* and *multiporella*).]

Stachyspongia, Zitt.

Siphonocœlia p. p., Röm.

Sponge cylindrical, much elongated, rather narrowed at both ends, very thick-walled, with a simple central cavity traversing the whole sponge. Rather large conical tubercles on the outside. Skeletal and canal-system as in *Scytalia*. Cretaceous.

1. *Siphonocœlia spica*, Röm. Spongit. xi. 5. Tourtia.

2. *Siphonocœlia tuberculosa*, Röm. ib. xi. 4. Senonian, Sutmerberg.

Pachinion, Zitt.

Jerea p. p., Röm.

Sponge cylindrical or clavate, simple, narrowed towards the base, short-stalked. Central cavity wide, simple, deep; at its lower end with several vertical tubes continued into the base. The thick wall appears to the naked eye composed of coarse anastomosing fibres, between which are wide irregular spaces for the circulation of water. The corpuscles are of considerable size, crooked, branched at the ends, and covered with short tubercles and knobs. Covering-layer composed of small, elegant, filigreed and strongly branched corpuscles, and of innumerable forked anchors (Pl. VIII. fig. 8) stuck among these with the shaft directed inwards.

1. *Jerea scripta*, Röm. Spong. xiii. 1. *Mucronatus*-Chalk of Schwiechelt and Thadensen near Duddenstedt.

Family 2. **Megamorina.**

Megalithista, Zitt.

Eulespongia p. p., Quenst.

Sponge pyriform, cylindrical, or cup-shaped, thick-walled, with rather wide, tubular central cavity. Both surfaces with round, irregularly scattered ostia of different sizes, from which large canals penetrate the wall. Corpuscles very large, smooth, curved, usually with two or three branches at each end (Pl. VIII. fig. 4), with shorter or longer axial canals. They are irregularly interwoven. Small, simple, bacillar spicules, and a few forked anchors also occur. The typical species, from the Coral Rag of Nattheim, is

1. *Megalithista foraminosa*, Zitt.

Irregularly cylindrical or elongate-ovate; surface sometimes with a few broad longitudinal folds or tubercles. Ostia of various sizes, the larger not uniformly distributed, but concentrated upon particular parts. Central cavity rather wide. Upper margin rounded.

Hitherto confounded with *Cylindrophyma milleporata*, Goldf. Possibly one of the two fragments described by Quenstedt (Petr. cxx. 7) as *Eulespongia*, from the White Jura of the Oerlinger Thal, near Ulm, belongs to this genus.

Doryderma, Zitt.

Spongia, Phill.
Polyjerea p. p., Röm.
Dichojerea p. p., Pom.

Sponge simple or compound, cylindrical, pyriform, flat, or composed of cylindrical, forked branches rounded at the ends. Internally with several vertical tubes parallel to the longitudinal axis. Surface with mesh-like openings ½ to 1½ millim. in diameter, formed by a reticulate arrangement of the skeletal corpuscles. From these ostia simple radial canals penetrate the sponge-body. Skeleton composed of very large, smooth corpuscles of irregularly branched structure (Pl. VIII. fig. 3); their thick arms more or less curved, forked once or twice, never running into root-like processes at the ends. Axial canal short, simple, rarely divided into two or three short branches. The corpuscles are loosely interlocked, and form a coarse network at the surface. In well-preserved specimens the meshes are filled with a dense tuft of long-shafted forked anchors. The end of the shaft, which is directed inwards, is pointed; the opposite end thickened and furnished with three very short prongs, which are generally forked. Smooth bacillar spicules also occur.

The skeletal corpuscles from the Greensand of Haldon, figured by Carter (Ann. & Mag. Nat. Hist. 1871, vol. vii. pl. viii.), very probably belong to this genus, as also the anchors figured by him (*l. c.* pl. x.) under the name of *Geodites haldonensis*. An example of the spicules described by Carter as *Monilites* (*l. c.* pl. ix. figs. 46, 47) has also occurred in *Doryderma*.

1. *Polyjerea dichotoma*, Röm. Spong. xvi. 1; Quenst. Petr. cxxxv. 10, 11. Senonian.
2. ? *Spongia ramosa*, Mant. Geol. Sussex, xv. 11. Senonian.
3. *Doryderma cylindrica*, Zitt.

Simple, cylindrical, narrowed above, below with a short stalk. Several scattered vertical tubes in the interior. In the *Mucronatus*-Chalk of Ahlten and Biewende.

Lyidium, O. Schmidt.

(Atlant. Spong.)

(*Recent.*) Sponge basin-shaped, on both surfaces with the large, round ostia of simple canals. Skeletal corpuscles smooth, crooked, branched, the branches terminating in a disciform or cup-shaped dilatation. In the sarcode of the surface numerous simple bacillar spicules of considerable size. (Species *Lyidium torquilla*, Schm. Cuba. See p. 244.)

Carterella, Zitt.

Jerea p. p., Röm., Gümb.
Eulespongia p. p., Quenst.

Sponge cylindrical, much elongate, narrowed below; vertex rounded off, convex, with the scattered apertures of several round, quill-like vertical tubes, which traverse the whole sponge. Surface with irregular, usually elongate, ostia; below with longitudinal furrows. Numerous fine horizontal radial canals run from the surface to the centre. Corpuscles large, filiform, undulated or crooked, blunt, with long and large axial canals, sometimes with short tubercles, and sometimes slightly branched at the ends. They are grouped into thick cords parallel to the main axis, and closely interwoven. Among them in parts are small, strongly branched and tubercular corpuscles. Cretaceous.

1. *Carterella cylindrica*, Zitt.

(=*Jerea arborescens, cylindrica,* and *elongata,* Gümb. Ostb. Grenzgeb. p. 761.)

Very long, cylindrical, simple, rarely dichotomous above, laterally somewhat compressed, with a long, simple, strongly furrowed root; vertex rounded. Surface coarsely reticulated, with numerous straight horizontal canals, which give the transverse section a radiate appearance. Whole sponge traversed by several vertical tubes, and composed of coarse, smooth, curved, filiform spicules, which rarely show a tendency to fork. Greensand of Kelheim and Regensburg; very abundant.

*2. *Jerea spiculigera*, Röm. Spong. xii. 6; Quenst. Petr. cxxxv. 1, 2. *Cuvieri*-Pläner and *Mucronatus*-chalk.

?3. *Eulespongia*, sp., Quenst. ib. cxxxv. 1, 2. *Cuvieri*-Pläner.

Heterostinia, Zitt.

Cup-shaped, usually stalked, with a branched root. Both surfaces with the scattered impressed ostia of radial canals. Vertical canals in the stalk. Skeleton of two kinds of elements of different sizes. The smaller, which form the principal mass, are strongly bent, much-branched, and filigreed all over; the larger ones smooth, branched, with attenuated and pointed ends.

The only known species, *Heterostinia cyathiformis*, Zitt., is from the Senonian of Rouen. In external form it agrees perfectly with the figures of *Chenendopora subplena* and *obliqua*, Mich. Ic. xli. 1, 2; and it is probable that one of these is identical with the present species. Numerous specimens are in the Museum of Geneva.

Isorhaphinia, Zitt.

Siphonocœlia p. p., Röm.
Eulespongia p. p., Quenst.

Cylindrical, simple, narrowed below, stalked, truncate above; wall of moderate thickness, central cavity wide, tubular. Surface smooth, without large ostia. The whole sponge-body composed of very large, slightly curved, cylindrical spicules, thickened, but rarely dichotomous at the ends, with a wide and long axial canal. In the interior of the wall these spicules are united in bundles, their somewhat bent extremities being at regular distances interlocked so as to form knots, in each of which several radiating bundles of spicules unite so as to reproduce on a large scale the appearance of a quadriradiate Lithistid corpuscle. On the surface spicules of the same form and size lie irregularly, forming a covering-layer, sometimes 1–3 millim. in thickness. No free spicules of different form were observed.

1. *Siphonocœlia texta*, Röm. Spong. x. 11. Very abundant in the *Cuvieri*-Pläner of Döhrnten near Salzgitter. Quenstedt gives good figures of it under the name of *Eulespongia texta*, Petr. cxxxv. 3–7.

Siphonocœlia hirta, Röm. Spong. xi. 6, also possibly belongs to this genus.

Family 3. **Anomocladina.**

Cylindrophyma, Zitt.

Scyphia auct.
Siphonocœlia p. p., From.
Hippalimus p. p., D'Orb.

Cylindrical, somewhat narrowed below, thick-walled, with a wide tubular or funnel-shaped central cavity reaching to the base. On the wall of the stomachal cavity the round ostia of horizontal radial canals, which penetrate deeply into the walls, gradually becoming finer outwards. Surface with scattered smaller ostia connected with horizontal incurrent canals. In well-preserved specimens the lower part of the sponge-body is coated with a siliceous epidermis.

Skeleton composed of branched corpuscles, in which several smooth arms radiate from a central node; arms divided at the distal extremity into two or three short branches, running out into root-like fibres. These ends are applied to the similar ends of neighbouring corpuscles, forming cushion-like gnarled knots. As the arms often radiate from the centre at right angles, and their points of union are at nearly equal distances, the skeleton acquires a regular meshed texture, resembling the structure of certain Hexactinellidæ.

This genus is very abundant in the Upper Jura of Swabia and Franconia; but the specimens are usually badly preserved. In the lower beds (White Jura β and γ) the skeleton is almost always converted into calc spar; in the Upper White Jura (δ, ϵ, and ζ), on the contrary, the whole sponge is usually roughly silicified and ill adapted to examination. Good examples have been obtained from Gussenstadt, Sontheim, and Beuren. Only in the Upper Jura.

1. *Scyphia milleporata*, Goldf. iii. 2; Quenst. Petr. cxxi. 1–7.
2. *Scyphia milleporacea*, Goldf. xxxiii. 10.

MELONELLA, Zitt.

Siphonia p. p., Goldf., Quenst.

Sponge pomiform or semiglobose, with a broad or very short-stalked base. Under surface with a wrinkled, dense siliceous membrane. Central cavity funnel-shaped, deep, but not very broad. Wall of the stomachal cavity with numerous round ostia standing in longitudinal series. The principal canals are curved parallel to the outer contour line and crossed by a second system of rather finer water-canals, which run from the base of the stomachal cavity obliquely upwards and outwards. These latter (incurrent) canals open on the surface in round ostia of moderate size. In worn specimens the concentrically curved canals appear as furrows radiating from the vertex. Skeleton as in *Cylindrophyma*, in all known specimens converted into calcite.

In external form resembling *Aulocopium* and *Siphonia*. Found only in the Upper Jura.

1. *Melonella* (*Siphonia*) *radiata*, Quenst. Jura, p. 679, Taf. lxxxii. fig. 13, and Petr. cxxvi. 60–72.

Siphonia piriformis p. p., Goldf. xxxv. 10 (non vi. 7).

LECANELLA, Zitt.

From depressed funnel-shaped to basin-shaped, thin-walled, both surfaces with fine pores, with no developed canal-system; wall becoming rather thinner towards the upper margin. Skeleton consisting of irregularly branched corpuscles of considerable size, having 4–6 smooth branches spreading from a nodiform or discoidal centre, and dividing at the ends into two or three short, rounded, conical branchlets. They bear no processes. The superficial corpuscles are more regular in form, and may perhaps be regarded as greatly modified forked anchors with a short shaft. The surface is also covered with large simple bacilli and innumerable *Geodia*-like spherules.

A fragment of a very depressed funnel-shaped specimen from the White Jura ε of Sontheim indicates a diameter of 150 millims. The corpuscles are loosely united and form an irregular network, reminding one of the latticed texture of the Hexactinellidæ. This texture distinguishes the sponge from *Platychonia*, which it otherwise closely resembles. This species is named *Lecanella pateræformis*. Probably Quenstedt's *Spongites flabellum* (Petr. cxxxi. 7) also belongs here.

MASTOSIA, Zitt.

Sponge nodular, with a broad hollowed base. Upper surface with numerous large mammiform tubercles. The surface of the tubercles and their interspaces uniformly finely porous. No oscula, and no distinct canal-system.

Corpuscles small, consisting of a thickened centre from which six to eight, smooth, straight, or slightly curved arms issue. The union of these arms, either with the nodes or arms of neighbouring corpuscles, produces a hexactinelliform lattice-work (Pl. VIII. fig. 5).

The whole of the original specimen is set with spicules and isolated siliceous corpuscles, only a portion of which probably belongs to *Mastosia*. *Geodia*-like spherules are the most abundant. There are also large and small bacillar spicules, pointed at one or both ends, small cylindrical spicules with rounded ends, simple quadriradiates with smooth and spiny arms, spicules with a short shaft and short forked anchors.

This remarkable new genus is known only from the passage-beds of the White Jura ϵ and ζ at Sozenhausen, near Günzburg, where it was obtained by M. Wetzler. The largest specimens attain a diameter of nearly 2 decims. The species is named *Mastosia Wetzleri*.

[To be continued.]

XLIV.—*Remarks upon the Porcellanidea of the West Coast of North America.* By W. N. Lockington.

The accompanying list of Porcellanidea (which includes descriptions of nine species I believe to be new, since they are certainly distinct from any of those described or mentioned by Stimpson as found upon this coast) does not profess to be complete, but merely to give facts of distribution and other particulars respecting forms with which I am acquainted.

Stimpson, in his 'Prodr. des Anim. évert.' 1858, divides the old genus *Porcellana* into the following genera:—*Petrolisthes*, *Pisosoma*, *Raphidopus*, *Pachycheles*, *Megalobrachium*, *Porcellana*, *Minyocerus*, *Porcellanella* (White), and *Polyonyx*.

In the first two of these the first joint of the antennal base is short, not reaching the margin of the carapax; while in all the others the first joint is more or less produced, and joined to the margin of the carapax.

The more convex carapax, stouter chelipeds, and less projecting front are the characters which separate *Pisosoma* from *Petrolisthes*; but as some of my species have some of the characters of the former genus, while they are without others, I find it exceedingly difficult to discriminate. I have therefore included *Pisosoma* in *Petrolisthes*, placing the former name in brackets before the specific names of such species as, in my belief, will belong to it if it be retained by carcinologists. Of the other genera, *Pachycheles*, *Porcellana*, and *Polyonyx* are found on this coast. These genera are distinguished from each other by well-marked characters: the first by its stout rough chelipeds and short carpus; the second by the long narrow carapax, prominent front, and deep orbits; and the third by its broad carapax, and by the bi- or multiunguiculate dactyli of the ambulatory feet. The former character distinguishes *Polyonyx* from *Porcellanella* (White).

Most of the Pacific-coast species belong to the genus *Petrolisthes*, which is, moreover, by far the largest section of the old genus *Porcellana*.

The total number of species here recorded is sixteen, nine of which I believe to be new; twelve belong to *Petrolisthes* (including *Pisosoma*), two to *Pachycheles*, one to *Porcellana* as restricted by Stimpson, and one to *Polyonyx*.

I have examined specimens of all the species except *Petrolisthes gracilis*, *eriomerus*, and *occidentalis*.

All the presumably new species here described are from either the east or west coast of the peninsula of Lower California, a district which has not as yet been thoroughly explored for its marine fauna, although large collections of birds, fishes, echinoderms, and alcyonarians have found their way thence to the museums of the eastern States.

Genus Petrolisthes.

a. Carapax flat, ovate; carpus at least twice as long as wide.

- Carpus three times as long as wide; anterior and posterior margins parallel, straight, and smooth, with a sharp tooth at posterior distal end .... *P. gracilis*.
- No teeth in front of carpus, but a prominent inner lobe and a tooth at posterior distal end; front triangular, depressed .... *P. rupicolus*.
- Front less prominent than in the last species; no prominent inner lobe to carpus; posterior margin of carpus denticulated .... *P. eriomerus*.
- Carpus with two or three teeth in front and a tooth at posterior distal end; dactylus of larger cheliped strongly hooked; all the limbs fringed with long setæ .... *P. hirtipes*.
- Postorbital tooth not spinous; carapax covered with short plications; carpus with four blunt teeth in front .... *P. crenulatus*.
- Postorbital tooth spinous; a second spine behind this, from which a ridged margin runs backward; carapax and chelipeds rugose ...... *P. occidentalis*.
- Postorbital tooth obtuse, a spine behind it; carpus with three acute teeth in front; meros of

ambulatory feet with two or three spines on upper edge, and one at posterior distal end. . *P. armatus.*
Pre- and postorbital spines acute; front boldly triangular, a spine behind postorbital; carpus spinous before and behind; chelipeds equal; meros of ambulatory feet with a row of spines anteriorly; carapax and all the limbs pubescent . . . . *P. Edwardsius?*
b. Carapax convex; carpus short; chelipeds stout.
Carpus nearly twice as long as wide; carpus and manus with three longitudinal rolling ridges; chelipeds equal. . . . . *P. sinuimanus.*
Carpus as broad as long, front margin laminate; hands flat; chelipeds subequal . . . . *P. gibbosicarpus.*
Hands dissimilar; carpus nearly as broad as long, its laminate front margin with three crenulated teeth . . . . *P. setimanus.*
Carpus as broad as long; front lamina in three low lobes; carapax and chelipeds smooth and shining; a white spot behind each eye on antero-lateral margin . . . . *P. biocellatus.*

Genus Pachycheles.

Carapax with a raised margin, front entire; chelipeds very unequal; carpus very short, not toothed in front; manus protuberant along the centre . . . . *P. rudis.*
Carapax and limbs with long pubescence, front trifid; chelipeds equal, with large tubercles above; carpus with a single large lobular tooth in front . . . . *P. tuberculipes.*

Genus Porcellana.

Carapax exceedingly elongate; postorbital acute, a spine on antero-lateral margin behind; chelipeds subequal; a small spine in front of carpus . . . . *P. transversilineata.*

Genus Polyonyx.

Carapax and limbs smooth; chelipeds equal; carpus with a deep concavity in front for the manus; dactyli of ambulatory feet multi-unguiculate . . . . *P. nitidus.*

Petrolisthes gracilis, Stimpson.

Petrolisthes gracilis, Stimpson, Ann. Lyc. Nat. Hist. vii. p. 74.

I have not examined any specimens which answer to Stimpson's description of this species.

Petrolisthes rupicolus, Stimpson.

Petrolisthes rupicolus, Stimpson, Prodr. des Anim. évert. p. 65.

This species appears to have a wide range. To the south it extends along the west coast of Lower California (Asuncion

Island, *Fisher*), and also along the Gulf coast of the same peninsula (Port Escondido; Las Animas Bay, *Fisher*); it is found on the islands of the Santa-Barbara group (Santa-Rosa and San-Miguel Islands, *Harford*), and thence by Monterey and the Farallones northward at least to Tomales, on the ocean-beach near which place I have procured it in abundance. Probably it extends much further to the northward.

It is abundant on rocky beaches in some parts of San-Francisco Bay.

Petrolisthes eriomerus, Stimpson.

Petrolisthes eriomerus, Stimpson, Ann. Lyc. Nat. Hist. N. Y. x. p. 119.

It is not very unlikely that this may prove to be a variety of *P. rupicolus*. All the examples of the latter species that I have examined have the tuft of hair between the fingers below; in many the posterior or outer edge of the carpus appears denticulated in consequence of the projecting edges of the short rugæ, which continue some distance down the outer surface; and the prominence of the laminate inner lobe varies in different specimens. I have a young *Petrolisthes* which has a slightly triangular front (projecting much less than that of a somewhat larger *P. rupicolus*), and the two sides of the carpus parallel. So far it agrees with *P. eriomerus*; but the posterior margin of the carpus is not denticulated, and the ambulatory feet are not "everywhere hairy," but covered with granules, except a few hairs on the dactyli.

I believe this specimen to be the young of *P. rupicolus*.

Petrolisthes hirtipes, nov. sp.

Carapax slightly longer than wide, somewhat pentagonal, a single lobular tooth behind the eye; upper surface tomentose, granular anteriorly.

Front three-lobed, margined with setæ, central lobe low and broad; no postorbital spine.

Eyes large and projecting.

Antennal peduncle armed with tubercles, the largest on the anterior portion of the penultimate joint.

Meros of chelipeds short, with a long tooth at its anterior distal end; carpus about twice as long as wide, with two or three teeth on its anterior margin, and a long tooth at its posterior distal extremity; manus flattened, thickest along the centre of its length, and broadest at the insertion of the dactylus; dactyli dissimilar, that of the left cheliped stout, inserted somewhat obliquely, and very strongly hooked at the tip, which is obtuse and overpasses that of the pollex, that of the right cheliped with the inner edge straight, the tip sharp-pointed and slightly bent; pollex of right cheliped with an obtuse tip, that of left sharp and slightly bent inwards.

Upper surface of manus, carpus, and meros covered with tubercles; two distinct longitudinal series of tubercles on each dactylus; the inner margin of the left dactylus, outer margin of both propodi, and inner margin of carpus clothed with a fringe of long setæ.

Ambulatory limbs tomentose above, with a long fringe of setæ on both margins; upper surface granular.

Length of carapax 7 millims., width 6.

Dredged in five fathoms, Mulege Bay, Gulf of California; also at Port Escondido. Several specimens.

The tubercles of the chelipeds are tipped with red (in spirits); and the bent tip of the left dactylus is bright red.

When the tomentosity of the carapax is rubbed off, the channel between the orbital and antero-lateral margins and the postgastric sulcus are distinct.

The long setæ which fringe the limbs are themselves regularly fringed along both sides with shorter setæ, appearing like a row of feathers, each with its shaft and pinnules.

Petrolisthes crenulatus, nov. sp.

Carapax covered with short plications, becoming rugæ toward the front and antero-lateral margins; gastric region elevated considerably above the frontal and orbital, the antero-lateral margin continuous, with four lobes, which bound the gastric region anteriorly.

Front deflected, consisting of the obtuse preorbital lobes and an obtuse-angled central lobe projecting slightly beyond them; postorbital tooth slightly marked, not spinous.

Cardiac region well defined by longitudinal sulci; two transverse sulci traceable across the entire carapax, the anterior enclosing the gastric region.

Chelipeds long and flattened. Meros with a blunt tooth at its anterior distal angle; carpus more than twice as long as wide, with four blunt teeth on its anterior margin, the two central largest; manus without spines; fingers of right and left chelipeds differing slightly, those of the right slightly gaping, and the right pollex with a blunt tooth.

Carpus and manus squamoso-granular, becoming granular on the manus; the upper surface of both joints tomentose toward the outer margin, especially near the elbow.

Ambulatory feet smooth, margined with long hairs anteriorly.

Length of carapax 10 millims., width 10.

Port Escondido, Gulf of California. A single specimen.

Petrolisthes occidentalis, Stimpson.

Petrolisthes occidentalis, Stimpson, Ann. Lyc. Nat. Hist. N. Y. vii. p. 73.

Stimpson says of this species that it is scarcely to be distinguished from *P. sexspinosus*, Gibbes; "but the carapax is slightly broader, the spines less prominent and acute, and the abdomen and feet more pubescent."

As he adds that the examination of a large number of specimens is necessary to establish these differences with certainty, it is evident that he did not feel sure of the specific distinctness of the form.

The characters given in the synopsis at the commencement of this article are taken from Gibbes's description of *P. sexspinosus* (Proc. Am. Assoc. 1850, p. 190).

I have not, to my knowledge, yet seen this form.

Petrolisthes armatus, Gibbes.

Petrolisthes armatus, Gibbes, Proc. Am. Assoc. 1850, p. 190.

Among the miscellanea from Lower California I find two specimens which I refer to this species.

The front is sinuous, the central portion arched forward, no preorbital spine; postorbital tooth obtuse; a little in the rear of the latter an acute spine, from which a not very prominent raised border runs backward around the carapax, which is punctate posteriorly, but with short rugosities anteriorly and on the margius.

Meros of chelipeds with a spine in front. Carpus almost three times as long as wide, armed with three large distant spines in front, and ten small ones along its raised outer margin; distal margin of carpus lobular; manus with a raised inner margin, the outer denticulate with a row of small spines, largest in the central portion of the palm, and passing into tubercles anteriorly and posteriorly; dactylus with a raised upper border; opposed edges of dactylus and pollex finely serrated. Meros of second pair with five or six small spines on anterior margin, that of third pair with six more prominent spines, that of fourth pair with four spines. A prominent spine at the posterior distal end of the meros of the second and third pairs, but none on the fourth pair. A long slender spine upon the posterior distal angle of the propodus of each of the ambulatory feet.

Ambulatory feet with long setæ, especially upon the three terminal joints, which show traces of bands of darker and lighter tints—red and straw-colour in the specimen (in alcohol).

The anterior border of the front is crenulate when viewed from above, and the antepenultimate joint of the antennal base has an anterior spinous lobe.

Stimpson mentions that most of his specimens had the outer edge of the hand smooth.

In one of the specimens there are two spines at the posterior distal extremity of the meros of third and fourth pairs; the carpus of the right cheliped has four spines in front, that of the left three; and of the denticulations on the posterior edge of the carpus only those at the distal extremity are developed into spines, four on the left and three on the right carpus.

Thus this species is subject to considerable variation.

My examples were from Mulege Bay, Gulf of California.

Petrolisthes Edwardsius, De Saussure.

As I have not seen De Saussure's description of this species (Rev. et Mag. de Zool. v. p. 366, pl. xi. fig. 3, *teste* Stimpson), and have only Stimpson's short description (Crust. & Echi. P. S. N. A. p. 40) to guide me, a description which will apply equally well to *P. armata*, I cannot be sure whether the two specimens I have before me (and I have seen others like them) are to be referred to *P. Edwardsius* or to a previously undescribed specific type. If the latter should prove to be the case, I would name the species *P. hirtispinosus*.

To facilitate identification I subjoin a description.

Entire surface of the carapax covered with short pubescence, beneath which the surface appears to be somewhat striated.

Gastric region elevated above the frontal and orbital, its raised anterior boundary passing into the lateral margin of the carapax above the level of the lateral spines.

Front triangular, depressed, projecting as much as that of *P. rupicola*; preorbital spine acute, separated from the central portion by a deep sinus; postorbital spine acute, with a broad base, above and behind which is a second, slender spine, merging into the rounded antero-lateral border.

A tooth on the penultimate, and a lobular tooth, ending in a spine, on the antepenultimate joint of the antennal base.

Distal border of the mandible with five or six small teeth.

Meros of chelipeds with a spine in front; carpus nearly three times as long as wide, with four or five large triangular teeth in front, ending in spines, followed by some spinose tubercles at distal end; central line of carpus elevated, posterior border with about nine small teeth; manus long and slender, an elevated line running longitudinally along it at about one third of its width from the raised interior margin; outer margin denticulate, sometimes spinous (a young specimen has a row of six or seven spines).

Surface of chelipeds covered with squamose ridges with a crenulate edge, and thickly pubescent. The longitudinal ridge on the carpus is formed of prominent oblique squamæ, and that of the manus of a row of longitudinal crenulate squamose teeth, passing into a line of tubercles down the centre of the dactylus, which has a beaded upper margin. Fingers closely fitting, hooked at the tip. Chelipeds equal.

Meros of ambulatory feet with a row of spines, hidden among long setæ, on the anterior border, and a spine at distal end posteriorly on the second and third pairs; a slender spine at posterior distal end of propodus. Last three joints of these feet with long hairs and traces of colour (blue and red); meros pubescent.

Mulege Bay, Gulf of California.

Petrolisthes (*Pisosoma*) *sinuimanus*, nov. sp.

Carapax almost orbicular, somewhat convex, punctate, becoming granular on the lateral margins; front sinuous in three low lobes, the centre one very small, the preorbitals very long and low; sulci enclosing the gastric and cardiac regions distinct in young specimens, which have the carapax smooth.

Eyes very small; external antennæ very short, scarcely as long as the carapax.

Chelipeds equal, similar. Meros usually with a blunt lobe at its anterior distal end; carpus nearly twice as long as wide, usually with a single blunt tooth in the centre of its anterior margin; manus and dactylus forming an obtuse triangle, outer edge of manus and pollex serrated.

Upper surface of the carpus and manus with three longitudinal rolling ridges, divided by furrows equal to them in size, the entire upper surface of meros, carpus, and manus deeply punctate and granular; dactyli granular. Fingers hooked and crossing at the tip.

Ambulatory feet stout, punctate, the two anterior pairs with the posterior distal end of the carpus produced backwards.

Entire surface free from tomentosity or hairs, except two or three stout hairs on the underside of the dactyli of the ambulatory feet.

Length of carapax of largest specimen 5·5 millims., width of ditto 5·5.

Several specimens found under coral and stones at low tide at La Paz and Port Escondido, Gulf of California.

This species varies considerably: some few specimens are without a trace of the lobe upon the meros or of the tooth upon the anterior margin of the carpus; in others they are small, in others large and prominent. One specimen combines with the want of these teeth a carapax the surface of which is plicate upon the margins. The rolling ridges of the manus and carpus, and the deeply punctate surface of both, are constant characters.

This species is intermediate between *Petrolisthes* proper and Stimpson's *Pisosoma*, the carapax answering to the latter, the chelipeds approaching the former.

Petrolisthes (*Pisosoma*) *gibbosicarpus*, nov. sp.

Carapax smooth, somewhat convex, becoming slightly plicate on the postero-lateral margin, somewhat pentagonal, antero-lateral angles rounded; gastric and cardiac regions defined by sulci; front entire, sinuous; postorbital tooth very slender and acute.

Flagella of antennæ more than twice the length of the carapax.

Chelipeds subequal; meros with a laminate tooth at its anterior distal end above, and a spine on the underside distally; carpus as broad as long, the anterior upper margin entire, laminate, the lamina broadest near the proximal end; distal margin lobular; manus flattened, narrower than carpus; fingers gaping but slightly; dactylus hooked at tip and crossing the tip of the pollex.

Surface of carpus and manus punctate above when viewed with a lens, the carpus rugulose on its outer margin.

Ambulatory feet set with long hairs, especially upon their anterior surface, manus somewhat punctate; no hairs or pubescence on carapax or chelipeds.

Length and width of carapax equal, each measuring six millims. in the single female individual from which this species is described.

The hand and carpus show traces of decorative coloration, having a central area surrounded by a darker band.

The exact locality of my specimen is unknown; but it certainly came from Lower California.

From the comparative stoutness of the chelipeds and the slight projection of the front, this species would appear to belong to Stimpson's genus *Pisosoma*.

Petrolisthes (*Pisosoma*) *setimanus*, nov. sp.

Carapax orbiculate, regions circumscribed by sulci, that behind the gastric region deepest. Postero-lateral regions crossed by rugæ.

Front entire, rounded, very slightly projecting in the centre; postorbital tooth acute.

Eyes prominent, peduncle short.

Chelipeds short and stout; meros with a crista or large tooth at its anterior distal end; carpus but little longer than wide, upper surface laminate anteriorly, the thin portion with three teeth, the proximal largest, teeth crenulate along their edges; upper surface of carpus, as well as the large teeth or crests, beset with granules.

Hands dissimilar, sometimes the right, sometimes the left being the larger. Palm of larger hand as broad as long, thick, covered with smooth circular tubercles; pollex stout, short, curved; dactylus almost cylindrical, punctate, longer than the pollex; fingers gaping widely, but crossing at the tip.

Smaller hand with the fingers parallel and in contact throughout.

Anterior surface of carpus and manus of both chelipeds beset with hairs, longest on the margin.

Ambulatory feet fringed with scattered long hairs.

Length of carapax 9 millims., width 9.

Colour (in alcohol) bright red, deeper on the chelipeds.

Mulege Bay, San-José Island; both in the Gulf of California.

The dactylus in the larger hand is inclined at an angle of about 40° with the anterior margin of the palm.

The specimens were taken in August or September; and the females are loaded with ova.

The tubercles of the hand increase to teeth on the outer margin, which is thus serrated.

Petrolisthes (*Pisosoma*) *biocellatus*, nov. sp.

Carapax orbicular, convex, regions indistinct; front entire, almost straight, postorbital spine acute.

Chelipeds short, stout, equal; meros laminate at its distal anterior end; carpus as broad as long, the upper anterior portion produced forwards as a thick lamina, divided into three low lobes; manus stout, the palmar portion about equal in length to the carpus.

Surface of carapax and chelipeds smooth and shining, without hairs or setæ; carpus and meros of chelipeds somewhat squamose when viewed with a lens.

Ambulatory feet beset with long setæ on their anterior surface.

Colour (in spirits) bright red, a round white spot on each shoulder; tips of the fingers white.

The larger of the two specimens measures barely three centimetres in length.

Exact locality unknown. Lower California.

This pretty little species is a typical *Pisosoma.*

Pachycheles rudis, Stimpson.

Pachycheles rudis, Stimpson, Ann. Lyc. Nat. Hist. N. Y. 1862, vii. p. 76.

Stimpson states that this species was found "near San Francisco." I have not succeeded in finding it within the bay; but it may probably inhabit the rocky ocean-beach at no great distance from the Golden Gate.

The most southern locality I have on record for this species is Santa-Rosa Island (*W. G. W. Harford*); but among numerous bottles of material from Lower California I find one without a label which contains several young specimens.

In young individuals the tubercles or large granules of the manus and carpus are less prominent than in the adult.

The frontal region is densely pubescent, and the surface of the carapax striated toward the margins.

Pachycheles tuberculipes, nov. sp.

Carapax and limbs covered with dense and long pubescence, except in the central portions of the former; under surface smooth.

Front depressed; central portion triangular, deeply furrowed along the median line; preorbitals acute, deflected; carapax nearly smooth in the centre, tuberculate near and along the margin, somewhat convex.

Eye-peduncle fitting closely between the pre- and postorbital teeth.

Antennæ distant from orbit; peduncles rough.

Chelipeds and ambulatory feet a mass of tubercles above; tubercles covered with granules, especially upon the manus. Chelipeds subequal.

Carpus with a tubercular tooth on the anterior margin at its superior proximal extremity; shorter than the meros when viewed from below.

Manus more than twice the length of the carpus; dactyli parallel, hooked at tip, with a smooth rounded ridge along the upperside.

Length of carapax about 3·5 millims., width about 3·5 millims.

Locality. La Paz, Gulf of California.

Five specimens of this singular form were found mixed with other species, in one case from La Paz, in others from other ports on the Gulf.

The thick pubescence and the large size and granulated surface of the tubercles on the upper surface of the chelipeds render it extremely difficult to make out details, while at the same time they give it an unmistakable aspect.

The large tubercles on carpus and manus, knobbed ambulatory feet, and equal-sized chelipeds at once distinguish this species from *P. rudis*.

Porcellana transversilineata, nov. sp.

Carapax elongate, length to width as one and a half to one; a pair of transverse prominences, almost amounting to teeth, just behind the frontal region, followed by several series of short rugæ forming interrupted transverse lines across the carapax; rugæ becoming longer and more distinct posteriorly, where they are frequently capped with a very short fringe of setæ directed forward.

Gastric region distinctly outlined. Lateral margins of carapax thin, crossed by regularly disposed short rugæ, and ending anteriorly in a sharp spine separated from the post-orbital spine by a deep notch.

Front tridentate; teeth long and acute, central one longest; lateral teeth slightly deflected.

Eyes scarcely visible above, hiden beneath the broad bases of the lateral spines; eye-peduncles long.

A flat spine below each antenna, at the side of the epistome, directed forwards and inwards.

Chelipeds short, subequal; meros and carpus about equal in length, and equal to the palmar portion of the manus; meros with a sharp spine at its anterior distal end; carpus with a smaller spine near the centre of its length; manus broader and thinner than the preceding joints, sharp-edged on both margins, beset with long setæ having a club-like tip; fingers compressed, parallel, obtusely serrated on their inner edge.

Ambulatory limbs short, subequal, stout, sparingly beset with setæ.

All the limbs crossed by short squamose rugæ, similar to those of the carapax.

Abdomen long, the first two joints visible above when it is folded below the sternum.

Boca de las Piedras, Sinaloa, 3 fms.; also Angeles Bay, west coast, Gulf of California, 5 fms.

Several specimens, taken in September; females with ova.

Length of carapax 6 millims., width of ditto 4.

Polyonyx nitidus, nov. sp.

Carapax entirely smooth and shining, convex, transversely ovate, considerably broader than long, regions indistinct; front entire, straight; no post- or preorbital tooth.

Chelipeds smooth, shining, equal.

Meros stout, produced into a prominent lamina distally and anteriorly; carpus stout, about twice as long as wide, cylindrical except posteriorly, where there is a deep concavity for the reception of the posterior side of the manus; manus stout, cylindroidal, fringed anteriorly with long setæ; fingers short, abruptly hooked at tip, serrated, the dactylus longer than the pollex.

Ambulatory feet short, smooth, sparsely setose; meros somewhat compressed; dactyli multiunguiculate.

Length of carapax 7 millims., width 10.

Exact locality unknown; Lower California.

This specimen, found among some miscellanea of Mr. Fisher's collecting, evidently belongs to Stimpson's new genus *Polyonyx*, having the transversely ovate carapax, and entire front, which distinguish it from *Porcellanella* (White), and the multiunguiculate dactyli which characterize both genera.

The number of unguiculi does not appear to be equal on all the feet, as I counted four or five on the first ambulatory pair, and three only on the two succeeding pairs.

The first antennal joint is very long and the eyes minute, according to Stimpson's generic description. From *P. macrocheles*, Gibbes, it may be distinguished by the equal size of the chelipeds and the serrate edges of the fingers.

San Francisco, Sept. 5, 1878.

XLV.—*On a small Collection of Crustacea made by Major Burton in the Gulf of Akaba.* By Edward J. Miers, F.L.S. &c.

The Crustacea collected by Major Burton are not numerous, including but nine species in all, and belonging, with one exception (the cirripede *Tetraclita porosa*), to the Decapoda. All are well-known forms; but their examination gives the opportunity of bringing together under one head certain nominal species which have long been regarded on insufficient grounds as distinct, on which account the synonyma have been cited more fully than would otherwise have been necessary. It is of interest to note that the few species collected by Major Burton in this narrow gulf at the northernmost extremity of the Red Sea are, with one exception (*Ocypode ægyptiaca*), forms whose geographical range extends as far eastward as the islands of the Pacific.

Carpilius convexus.

Cancer convexus, Forskål, Descript. Animal. p. 88 (1775).
Carpilius convexus, Rüppell, Beschreib. Krabben rothen Meeres, p. 13, pl. iii. fig. 2 (1830); M.-Edwards, Hist. Nat. Crust. i. p. 382, pl. xvi. figs. 9, 10 (1834); A. M.-Edw. Nouv. Arch. Mus. Hist. Nat. i. p. 215 (1865); Heller, Sitzungsb. &c. xliii. 1, p. 319 (1861).
Carpilius lividus, Gibbes, Proc. Amer. Assoc. p. 174 (1850).

One specimen, a female in fine condition, is in the collection. There can be little doubt that the *C. lividus* of Gibbes, based on Sandwich-Island specimens, is identical with this species, although his description is very short. Specimens in the British-Museum collection prove that the range of *C. convexus* extends to that locality.

I take this opportunity of noting that the *Carpilius prætermissus* of the same author (*l. c.*) seems to be identical with *Liagore rubromaculata*, De Haan.

Zozymus æneus.

Cancer æneus, Linn. Mus. Lud. Ulr. p. 451 (1764); Syst. Nat. p. 1048 (1766).
Cancer amphitrite, Herbst, Nat. Krabben u. Krebse, iii. (pt. 2) p. 5, pl. liii. fig. 1 (1801).
Zozymus æneus, M.-Edw. Hist. Nat. Crust. i. p. 385 (1834); Dana, U.S. Expl. Exp. xiii. Crust. i. p. 192, pl. x. fig. 3 (1852); Heller, Sitzungsb. xliii. 1, p. 326 (1861).

Two specimens, males, were collected.

Trapezia ferruginea.

Trapezia ferruginea, Latreille, Encycl. Méth. Hist. Nat. x. p. 695 (1825)?; M.-Edw. Hist. Nat. Crust. i. p. 428 (1834)?; Heller, Sitzungsb. Akad. Wien, xliii. 1, p. 349, pl. iv. fig. 40 (1861).
Trapezia cærulea, Rüppell, Beschreib. Krabben rothen Meeres, p. 27, pl. v. fig. 7 (1830); nec Heller, *l. c.* p. 348 (1861).
Grapsillus subinteger, M'Leay, Zool. S. Africa, Annulosa, p. 67 (1838).
Trapezia cymodoce, Dana, U.S. Expl. Exp. xiii. Crust. i. p. 25, pl. xv. fig. 5 (1852); Heller, *l. c.* p. 352 (1861), nec Herbst.
?*Trapezia miniata*, Jacq. & Lucas, Voy. Pôle Sud, Zool. iii. Crust. p. 43, pl. iv. fig. 10 (1853).
Trapezia subdentata, Gerstaecker, Arch. f. Nat. xxii. p. 127 (1856).

Two specimens, male and female, were collected. These have the carapace of a bluish-grey colour, and the limbs of a reddish brown. The teeth of the lateral margins are small and blunt, the frontal teeth not much developed, and the arms have 5–7 teeth on their anterior margins. The hands are rounded above and naked on their outer surface.

The discrimination of the species of this genus is very difficult; and I was at first inclined to unite under the name of *Trapezia cymodoce*, Herbst, all the specimens in the British-

Museum collection in which the carapace is armed with six more or less distinctly developed frontal teeth (including those forming the inner angle of the orbit), with a tooth or spine in the middle of the lateral margins, and which are not marked with red spots or reticulating lines.

The variations in the development of the teeth of the frontal margins cannot, in my opinion, be considered to constitute specific distinctions; and those of the arms vary in number and shape, even on the right and left sides of the same specimen. Dr. Heller has shown (*l. c.* p. 350) that M.-Edwards's description of the position of the outer maxillipedes of *T. ferruginea* when closed is incorrect; and there is no difference in this respect between *T. ferruginea* from the Red Sea and specimens of *T. dentifrons* from Australasia given by the Paris Museum to the British-Museum collection. Dr. Hilgendorf (Crust. in Van der Decken's 'Reisen in Ost-Afrika,' iii. p. 76), while acknowledging the insufficiency of the characters derived from the form of the teeth, and of the arms and front, seems to think that Rüppell may have been right in separating the species by their colour-variations only. A careful examination of the large series in the Museum collection has shown, however, that two very distinct forms may be distinguished, and always recognized, by the following characters:—In the first (and probably the commonest) *the lateral marginal teeth of the carapace are acute, the hand is subcristate above and below and hairy on its outer surface*; in the second, *the lateral marginal teeth are blunt or even almost obsolete, the hand is longer, rounded on its upper margin, and naked on its outer surface.*

To the latter, *T. ferruginea*, belong the specimens from the Gulf of Akaba, a very large series (upwards of sixty individuals) from the Dædalus Shoal, Red Sea, collected by Col. Playfair, specimens from the Gulf of Suez (*MacAndrew*), Mauritius (*Lady Cole*), and Samoa Islands (*Whitmee*), also probably the specimens from Tahiti and the Sandwich Islands referred by Dana to *T. cymodoce*, those from the Cape of Good Hope described by M'Leay as *T. subinteger*, and those from the Marquesas to which Jacquinot and Lucas have assigned the name of *T. miniata*. To the former species, which I have designated *T. cymodoce*, belong specimens in the Museum collection from the Dædalus Shoal (*Playfair*), Gulf of Suez (*MacAndrew*), Ceylon (*Holdsworth*), Philippine Islands (*Cuming*), Fiji Islands (*H.M.S. 'Herald'*), specimens from Australasia from the Paris Museum named *T. dentifrons*, Latreille, and the examples from the Marquesas described by Jacquinot and Lucas as *T. hirtipes*.

The synonyms of *T. cymodoce*, as far as ascertained, will run as follows :—

Trapezia cymodoce.

Cancer cymodoce, Herbst, Naturg. Krabben, &c. iii. (2) p. 22, pl. li. fig. 5 (1801).
Trapezia dentifrons, Latreille, Encycl. Méth. x. p. 695 (1825); M.-Edw. Hist. Nat. Crust. i. p. 429 (1834).
Trapezia hirtipes, Jacq. & Lucas, Voy. Pôle Sud, Zool. iii. Crust. p. 44, pl. iv. fig. 14 (1853).
Trapezia cærulea, Heller, Sitzungsb. *l. c.* p. 348 (1861), nec Rüppell.

In *T. cymodoce* the serratures on the anterior margin of the arm are more numerous, and the tooth on the inner surface of the wrist usually more marked than in *T. ferruginea.*

Several other species have been described, which are probably synonymous with one or other of the above; but further examination is needed of the types. There is nothing in the description of Latreille and Milne-Edwards to enable one to say which species must be designated *T. ferruginea*; and I assign this name to the first-mentioned form only because it is undoubtedly the one described as *T. ferruginea* by Heller.

In like manner I am unable to decide from the descriptions of Herbst and Gerstaecker to which species the typical specimen of *T. cymodoce* from the East Indies is to be referred, and conclude that it belongs to the second species only because Herbst's figure represents the hand as strongly keeled above.

I am not certain which species is intended by Hilgendorf (Crust. in Van der Decken's 'Reisen in Ost-Afrika,' iii. (1) p. 76, pl. ii. figs. 4, 5, 1869). His specimens were from Zanzibar.

Ocypode ægyptiaca.

Ocypode ægyptiaca, Gerstaecker, Archiv f. Naturg. xxii. p. 134 (1856); Heller, Sitzungsb. xliii. (1) p. 361 (1861); Hoffmann in Recherches Faune Madagascar, &c. Crust. p. 14 (1874).

One specimen (a male) was collected, and, unfortunately, in a mutilated condition: the styliform prolongations of the eyepeduncles, which vary greatly in length and shape, are, in this specimen, strongly arcuated and very slender; and the characteristic patch of thick hair on the under surface of the penultimate joint of the second legs is nearly obliterated. The examination of a considerable series of specimens evidences the distinctness of this species from the closely allied *O. ceratophthalma*, Pallas. *Ocypode ægyptiaca*, beyond the limits of the Red Sea, has only been recorded from the island of Nossy Faly, near Madagascar; but the series in the British-Museum collection shows that *O. ceratophthalma* is distributed throughout the Oriental region, and westward to the Mauritius and Port Natal.

Grapsus strigosus.

Cancer strigosus, Herbst, Naturg. Krabben, &c. iii. (1) p. 55, pl. lxvii. fig. 7 (1799).

Grapsus strigosus, Latr. Hist. Crust. et Ins. vi. p. 70 (1803); M.-Edw. Hist. Nat. Crust. ii. p. 87 (1837); A. M.-Edw. Nouv. Arch. Mus. Hist. Nat. ix. p. 286 (1873), *ubi synon.*

Several examples of this very common species were collected. The specimens referred by Heller (Sitzungsb. p. 362) to *G. pharaonis*, M.-Edw., may belong either to this species or the closely allied *G. pictus*.

Cœnobita rugosa.

Cœnobita rugosa, M.-Edw. Hist. Nat. Crust. ii. p. 241 (1837); Dana, U.S. Expl. Exp. Crust. i. p. 471, pl. xxx. fig. 1 (1852); Heller, Sitzungsb. Akad. Wien, xliv. 1. p. 254 (1862).

A large series of specimens of this common Indo-Pacific species are in the collection; they seem to have been selected with the view of showing the wide range of selection exhibited by the animal in choosing the shell which forms its habitation. The series collected inhabit shells of the following genera:—*Turbo*, *Fusus*, *Natica*, *Purpura*, *Murex*, *Tritonium*, *Ranella*, *Nassa*, *Harpa*, *Terebra*, *Cerithium*, *Dolium*, *Nerita*, *Cassidulus*.

In all the specimens the large, dark, circular patch on the outer surface of the hand (which is clearly defined in specimens from the islands of the Pacific) is indistinct or nearly obliterated.

Palinurus (*Panulirus*) *penicillatus.*

Astacus penicillatus, Olivier, Encycl. Méth. vi. p. 343 (1791).

Palinurus gigas, Bosc, Hist. Nat. Crust. ii. p. 93 (1802).

Palinurus penicillatus, Olivier, Encycl. Méth. viii. p. 674 (1811); M.-Edw. Hist. Nat. Crust. ii. p. 299 (1837).

Palinurus Ehrenbergii, Heller, Sitzungsb. Akad. Wissensch. Wien, xliv. 1. p. 260, pl. ii. fig. 8 (1862); Reise der Novara, Crust. p. 95 (1865).

Four specimens were collected of this species, all unfortunately in more or less imperfect condition.

Dr. Heller separated the Red-Sea *Palinurus Ehrenbergii* from the Indo-Pacific *P. penicillatus*, on account of the spines of the interantennal plate being connate at base in lateral pairs only, and separated in the middle line by an intervening space, and on account of the non-piliferous tubercles of the carapace; I find, however, that one of the Red-Sea specimens collected by Captain Burton has the spines of the carapace as piliferous as those of any of the specimens in the British-

Museum collection from the Fiji Islands and New Hebrides, and there is no difference in the position of the spines on the interantennal plate—in fact, that the forms from these widely separated localities belong to one and the same species. I conclude, therefore, that Milne-Edwards's description of these spines as "réunies à leur base en faisceau" is not strictly correct, and that their position is more correctly described by Heller, and that, as in so many other cases, the Red-Sea species is distributed over the whole Oriental region. Latreille gives the Mauritius, and Milne-Edwards the Indian Ocean as its habitat.

Alpheus lævis.

Alpheus lævis, Randall, Journ. Ac. Nat. Sci. Phil. viii. p. 141 (1839); Dana, U.S. Expl. Exp. xiii. Crust. p. 556, pl. xxxv. fig. 8 (1852); Heller, Sitzungsb. Akad. Wien, xliv. 1, p. 269, pl. iii. fig. 16 (1862).

One female individual of this very common Indo-Pacific species was collected. When dry, the larger hand is seen to be very prettily marked with spots of a dusky pink. *Alpheus insignis*, Heller (*l. c.* p. 269, pl. iii. figs. 17, 18), and *A. gracilis*, Heller (*l. c.* p. 271, pl. iii. figs. 19, 20), are both nearly allied Red-Sea forms: the latter comes particularly close; but both differ in having a transverse groove or impression on the upper margin of the larger hand near the base of the mobile finger, and in the proportional length of the joints of the wrist of the second pair of legs.

Tetraclita porosa, var. *communis*.

Tetraclita porosa, var. *communis*, Darwin, Monogr. Cirripedia, Balanidæ, p. 329, pl. x. fig. 1 *a* (1853).

Three specimens are in the collection.

XLVI.—*Descriptions of new Genera and Species of* Gallerucinæ. By Joseph S. Baly, F.L.S.

Genus Prasyptera.

Corpus ovatum, postice paullo ampliatum, convexum. *Caput* exsertum; *facie* perpendiculari; *clypeo* transverso vel transverso-quadrato, lateribus rectis; *encarpis* transversis, contiguis; *carina* lineariformi, paullo elevata; *antennis* filiformibus, gracilibus, articulo primo elongato, curvato, ad apicem incrassato, secundo brevi, tertio quam quartus breviore; *oculis* integris, prominulis. *Thorax* transversus, dorso leviter transversim excavatus. *Elytra* thorace latiora, convexa, confuse punctata; limbo inflexo fere ad apicem producto. *Pedes* graciles; *coxis* anticis fere contiguis;

tibiis apice spina acuta armatis; *tarsorum* posticorum articulo basali sequentibus tribus longiori; *unguiculis* appendiculatis. *Prosternum* angustissimum, acetabulis anticis apertis. *Abdomen* in fœmina gravida valde exsertum.

Type *Prasyptera Wallacei.*

Closely allied to *Astena*; separated from that genus by the shorter third joint of the antennæ.

Prasyptera Wallacei.

P. anguste oblonga, postice vix ampliata, fulva, nitida, oculis, antennis (articulis duobus ultimis basi albidis exceptis), scutello, tibiis tarsisque nigris; facie inferiore thoraceque rugoso-punctatis; elytris parce griseo pubescentibus, crebre punctatis, metallico-viridibus.

Long. 4 lin.

Hab. New Guinea, Dorey.

Head trigonate; eyes large, prominent; clypeus clothed with coarse griseous hairs, rugose-punctate; carina obsolete; encarpæ large, moderately thickened, contiguous; vertex smooth, impunctate; third joint of antennæ nearly twice the length of the second, scarcely half as long as the fourth. Thorax more than twice as broad as long; sides straight and scarcely converging from the base to beyond the middle, thence slightly rounded and converging to the apex, anterior angles thickened, obtuse; basal margin trisinuate; upper surface faintly excavated on either side, coarsely rugose. Scutellum trigonate. Elytra much broader than the thorax, coarsely and closely punctured, very sparingly clothed with griseous hairs; interspaces minutely punctured.

Prasyptera distincta.

P. anguste oblonga, postice vix ampliata, fulva, nitida, femoribus posticis apice, tibiis, tarsis, abdominis segmentis macula utrinque, pygidio apice scutelloque nigris æneo vix tinctis; capite nigro-æneo, antennis nigris, clypeo transverso-quadrato, rugoso, viridi-æneo; thorace transverso, lævi, dorso transversim excavato; elytris rude et crebre punctatis, metallico-olivaceis.

Long. 4 lin.

Hab. Wagiou.

Vertex black, with a faint metallic-green tinge; encarpæ thickened, subtrigonate, contiguous; clypeus brassy green, transverse-quadrate, rugose-punctate, plane, the carina entirely obsolete; antennæ with the third joint scarcely twice as long as the second, more than half the length of the fourth; all the joints to the eighth black (the rest, in the only specimen known to me, are wanting). Thorax more than three times as broad as long; sides straight and nearly parallel, the anterior angles obliquely truncate, the hinder ones produced, subacute; disk smooth and shining, moderately excavated transversely across the disk, the excavation not reaching to the lateral margin. Scutellum trigonate, shining black. Elytra oblong, broadly rounded at the apex, deeply and closely punctured, the interspaces irregularly elevate-reticulate.

Prasyptera ornata.

P. ovata, postice ampliata, valde convexa, sordide fulva, antennis (articulo primo basi excepto), tibiis tarsisque nigris; thorace transverso, rugoso; capitis macula verticali elytrisque metallico-olivaceis; his rugoso-punctatis, pube adpressa grisea parcissime vestitis, fascia lata, irregulariter biflexuosa ante medium posita, maculaque subapicali prope suturam fulvis; abdominis segmentorum maculis lateralibus pygidiique apice æneo-nigris.

Long. 4 lin.

Hab. New Guinea, Aru Islands.

Front impressed; joints above the encarpæ with a narrow longitudinal groove; encarpæ semilunate, contiguous; clypeus large, transverse-quadrate, rugose, faintly carinate on the median line, clothed with short adpressed hairs; third joint of antennæ twice the length of the second, scarcely more than half as long as the fourth; the lower two thirds of the basal joint obscure fulvous, its upper third, together with the remaining joints as far as the tenth, black*. Thorax three times as broad as long; sides obliquely converging from base to apex, more quickly converging and slightly rounded just behind the latter; the anterior angles armed with a very short excurved tooth; the hinder ones slightly produced, acute; disk transversely concave, rugose-punctate. Elytra subquadrate, oblong, broadly rounded at the apex, convex, strongly and closely punctured, the interspaces irregularly wrinkled; olivaceous with a metallic tint, each elytron with a broad biflexuose band before the middle, and a small spot close to the apex near the suture, obscure fulvous. Segments of abdomen each marked on either side with a large nigro-æneous patch; apex of pygidium also nigro-æneous.

Prasyptera approximata.

P. anguste oblonga, postice vix ampliata, fulva, nitida, capite, femoribus posticis apice, tibiis, tarsis, abdominis segmentis macula utrinque scutelloque nigris, antennarum articulo penultimo basi

* The terminal joint in the unique specimen from which the description was made is broken off.

albido, clypeo nigro-æneo; thorace transverso, dorso transversim depresso, utrinque leviter foveolato; elytris fortiter punctatis, metallico-viridibus, fascia communi arcuata extrorsum interrupta, ad suturam angulata, ante medium posita, maculaque subapicali juxta suturam, fulvis.

Long. $3\frac{2}{3}$ lin.

Hab. Malay peninsula.

Vertex smooth, impunctate; clypeus transverse-quadrate, subrugose-punctate, plane, the carina nearly obsolete; antennæ longer than the body, the third joint twice the length of the second, two thirds as long as the fourth. Thorax more than three times as broad as long; sides straight and obliquely converging from base to apex, the anterior angles obliquely truncate, the hinder ones slightly produced, acute; disk smooth and shining, impunctate, transversely depressed across the disk, the depression not extending to the lateral border, but impressed at either end by a shallow fovea. Elytra oblong, broadly rounded at the apex, strongly and closely punctured, bright metallic green; each elytron before its middle with a curved fulvous fascia, interrupted on the outer disk, but united at the suture to its fellow of the opposite elytron, and forming an acute angle, its apex directed backwards; close to the suture near its apex is an oblong concolorous spot.

Prasyptera Haroldi.

P. anguste oblonga, postice vix ampliata, sordide fulva, tibiis tarsisque piceis, abdomine flavo, capite (vertice carinaque exceptis) nigro, antennarum articulis ultimis tribus albidis; thorace transversim depresso, impunctato; elytris tenuiter punctatis, cyaneis.

Long. $3\frac{1}{2}$ lin.

Hab. Batchian.

Lower portion of head black; encarpæ strongly raised, contiguous, semilunate; clypeus smooth and concave on either side the carina, the latter linear, well defined, piceo-fulvous; antennæ very slender, equal to the body in length, the third joint nearly three times the length of the second, about three fourths as long as the fourth. Thorax three times as broad as long; sides nearly straight and parallel, rounded at the extreme apex, the anterior angles thickened, obtuse; disk nearly impunctate, transversely excavated across the middle, the depressions deeper and better-defined on either side, but not extending to the lateral margin. Elytra oblong, broadly rounded at the apex, very finely punctured.

Mimastra Soreli.

M. elongata, parallela, flava, nitida, metasterno abdomineque nigris, pube grisea vestitis; capite lævi, antennis extrorsum verticeque nigris; thorace lævi, irregulariter excavato, sæpe piceo maculato, lateribus rectis; elytris subcrebre, sat fortiter punctatis, tertia parte apicali nigro-cyanea; femoribus dorso, tibiis tarsisque piceo-nigris.

Var. A. elytris totis flavis.

Mas tarsis anticis articulo primo valde dilatato.

Long. $4\frac{1}{2}$–5 lin.

Hab. Valley of the Upper Yangtse Kiang. Collected by Lieut.-Colonel Sorel; also collected in China by Mr. G. Lewis; India.

Head smooth, impunctate; encarpæ large and well defined, trigonate, contiguous; eyes black, rotundate, prominent; antennæ with the basal joint gradually curved and thickened from base to apex, the second joint short, the third more than twice the length of the second, rather more than half as long as the fourth. Thorax twice as broad as long; sides parallel, rounded at the apex, the anterior angles produced, very obtuse; disk transversely and irregularly excavated, more deeply depressed on either side and at the base. Elytra broader than the thorax, distinctly but finely punctured.

Mimastra costata.

M. elongata, angustata, flava, nitida, tarsis nigro-piceis, antennis (basi exceptis) nigris; thorace lævi, transversim excavato; elytris nigris vel nigro-piceis purpureo-metallico tinctis, pube suberecta grisea parcissime vestitis, minus fortiter punctatis, singulatim costis elevatis duabus basi et apice abbreviatis instructis.

Mas tarsis intermediis articulo basali dilatato.

Long. 3–$3\frac{1}{2}$ lin.

Hab. China. Collected by Mr. Lewis.

Head shining, impunctate; encarpæ transversely oblong, contiguous, separated from the upper face by a deep transverse groove; eyes very large, much more nearly approximated than in *M. Soreli*; antennæ longer than the body in the ♂, rather shorter in the ♀, the third joint more than twice as long as the second, equal in length to the fourth. Thorax twice as broad as long; sides straight, slightly diverging from the base nearly to the apex; disk shining, impressed with a deep, broad, transverse excavation. Scutellum trigonate. Elytra more finely and less closely punctured than in *S. Soreli*; each on the outer disk with two strongly raised longitudinal costæ. Basal joint of hinder tarsus equal in length to the second one.

Genus Megalognatha.

Corpus elongatum, parallelum. *Caput* exsertum, infra oculos elongatum, plus minusve porrectum; *antennis* filiformibus, in ♂ interdum incrassatis, articulis intermediis difformibus; *oculis* ovalibus, integris; *encarpis* distinctis, contiguis; *carina* cuneiformi. *Thorax* subquadratus, lateribus fere rectis. *Scutellum* trigonatum. *Elytra* thorace paullo latiora, parallela, limbo inflexo pone medium obsoleto. *Pedes* graciles, simplices; *coxis* anticis contiguis; *tibiis* apice muticis, dorso carinatis; *tarsorum* posticorum articulo basali sequentibus tribus longitudine fere æquali; *unguiculis* appendiculatis. *Prosternum* angustissimum, *acetabulis* anticis apertis. *Abdomen* in fœmina gravida inflatum.

Type *Megalognatha elegans.*

The above genus is separated from *Malacosoma*, to which genus some of the species bear resemblance, by the strongly exserted head, the unarmed apices of the tibiæ, and by the shorter inflexed limb of the elytra.

Megalognatha elegans.

M. elongata, convexa, flavo-fulva, nitida, capite, antennis (basi exceptis) nigris; thorace sat fortiter punctato; elytris convexis, a basi apicem versus graduatim elevatis, viridi-æneis, granulosis, transversim rugulosis, crebre punctatis.

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

Hab. Graham's Town, South Africa.

Head porrect, elongate; vertex granulose, sparingly punctured; front impressed just above the encarpæ with a deep fovea; encarpæ transverse, subpyriform, contiguous; lower face strongly produced, nigro-piceous; clypeus triangular, remotely punctured, its median line elevated into an ill-defined longitudinal ridge; antennæ equal to the body in length in the ♂, rather shorter in the ♀, filiform, the second joint short, the third equal in length to the first; the three or four lower joints fulvous, the rest black. Thorax transverse-quadrate; the sides straight and slightly diverging from the base to beyond the middle, thence obliquely converging to the apex; upper surface deeply punctured, the punctures rather crowded and often confluent on the hinder disk, more distant in front; the hinder disk faintly excavated, the anterior with a shallow, ill-defined fovea. Scutellum trigonate. Elytra broader than the thorax, narrowly oblong, convex, faintly depressed below the basilar space, granulose, transversely wrinkled, coarsely punctured.

Megalognatha cavicollis.

M. elongata, nigra, nitida, abdomine fulvo; thorace rufo-fulvo, postice rude punctato, vix ante medium sulco semilunato transverso, fundo trifoveolato, antice elevato marginato, impresso; elytris thorace paullo latioribus, parallelis, convexis, pone medium inflatis, confuse punctatis, fulvis, fascia transversa prope medium communi, leviter curvata, longe intra marginem abbreviata, nigra.

Long. 3 lin.

Hab. Port Natal.

Vertex and front minutely granulose, the latter finely strigose immediately above the encarpæ; encarpæ separated from the front by a transverse groove, contiguous, transverse; carina strongly raised, linear; anterior border of labrum fulvous; antennæ nearly three fourths the length of the body, filiform. Thorax broader than long; the sides straight and slightly diverging from the base to some distance beyond the middle, thence rounded and converging to the apex, the anterior angle armed with an obtuse tubercle; hinder disk rugose-punctate, impressed just in front of the base with a short longitudinal groove; scarcely in front of the middle disk is a large, deeply impressed, semilunate sulcus, the surface of which is deeply trifoveolate, its anterior border thickened, the space immediately in front of the raised margin concave and nearly free from punctures. Elytra broader than the thorax, parallel, subelongate, convex, inflated below the middle, closely punctured, the interspaces granulose.

Megalognatha suturalis.

M. elongata, subcylindrica, sordide fulva, nitida, pectore, pedibus antennisque nigris; thorace transverso-quadrato, lateribus ante medium obsolete angulatis, margine basali medio leviter emarginato, disco rugoso-punctato, medio pone apicem obsolete transversim excavato; scutello piceo, apice fulvo; elytris parallelis, rude rugoso-punctatis, utrinque vitta elevata suturali pone medium alteraque submarginali instructis, prope medium macula transversa nigro-picea ornatis.

Mas abdominis segmento ultimo apice angulato, utrinque leviter sinuato.

Fœm. abdomine exserto, piceo tincto, segmento ultimo apice obtuse rotundato.

Long. 4 lin.

Hab. Port Natal.

Head moderately exserted, obliquely deflexed; vertex shining, impunctate; encarpæ transverse, slightly curved, contiguous; carina very short; antennæ moderately robust, nearly equal to the body in length, the apical half black, the terminal joint piceous; the second joint short, obovate, the third and fourth equal, each twice the length of the second. Thorax rather broader than long; sides parallel, obliquely converging at the apex, obsoletely angled before the middle; anterior angle produced, obtuse; middle portion of basal margin sinuate-emarginate; disk coarsely rugose-punctate, rather more sparingly punctured on the middle disk; in front, behind the apex, is a very shallow, ill-defined, transverse sulcation, which terminates on either side some distance within the lateral margin; just in front of the basal margin is a faint longitudinal depression. Scutellum longer than broad, its apex obtuse. Elytra subelongate, parallel, convex, coarsely rugose-punctate, the puncturing finer towards the apex; each elytron on its middle third near the lateral margin with a raised costa, the space on either side longitudinally excavated; the suture from its middle nearly to the apex is thickened and forms a longitudinal costa; before its apex this costa becomes subsutural, and leaves a very narrow space between itself and the sutural margin.

Megalognatha Bohemani.

M. elongata, subcylindrica, fulva, nitida, pectore, coxis tarsisque nigris, antennis piceis; thorace transverso, lateribus rotundatis, disco subremote tenuiter punctato, ante medium leviter subarcuatim excavato; scutello nigro-piceo; elytris sat crebre punctatis, linea suturali et utrinque vittis tribus nigro-piceis, prima brevi in disco interno, duabusque in disco externo positis, his a basi ad longe pone medium extensis, basi super callum humerale conjunctis.

Long. $2\frac{3}{4}$ lin.

Hab. Caffraria.

Head obliquely deflexed; lower face produced below the eyes; vertex shining, impunctate; encarpæ transverse, contiguous; carina not well defined, narrowly wedge-shaped, its surface impressed with a shallow fovea; antennæ rather more than half the length of the body, filiform, slightly thickened towards the apex, the second joint short, ovate, the third and fourth equal, each more than half as long again as the second. Thorax nearly twice as broad as long; sides rounded, the hinder angle nearly obsolete, the anterior one mucronate; disk finely but distinctly punctured, impressed just in front of the middle with an ill-defined, very shallow, subarcuate excavation, divided into two portions by a slightly and indistinctly raised vitta, the surface immediately in front obsoletely thickened. Scutellum trigonate, pitchy black. Elytra narrowly oblong, parallel, convex, rather strongly punctured, the interspaces granulose; each elytron with a narrow sutural line and three linear vittæ pitchy black; the first of these, much shorter than the others, is placed on the middle third of the inner disk near its outer edge, the two others commence on the outer disk at its base (where they unite and form an elongate patch on the humeral callus), and extend downwards to some distance below the middle of the elytron; the outer vitta is slightly thickened and subcostate for its whole length, and the space between the two vittæ immediately below the humeral callus is faintly excavated.

Megalognatha ventricosa.

M. elongata, parallela, subtus cum capite nigra, nitida, abdomine flavo; supra flavo-fulva; thorace transverso-quadrato; scutello piceo, griseo-sericeo; elytris tenuiter punctatis, infra basin transversim depressis, pone medium ventricosis.

Mas thoracis disco plano, impunctato, apice modice obtuse elevato; elytris pone medium modice inflatis.

Fœm. thoracis disco irregulariter excavato, apice valde elevato, cristam transversam formante; elytris pone medium valde inflatis.

Long. $3\frac{1}{2}$ lin.

Hab. Port Natal.

Head exserted, obliquely porrect; vertex impunctate; encarpæ raised, well defined, transverse, slightly curved, contiguous; carina short, not reaching the lower margin of the encarpæ, wedged-shaped, acute; labrum piceous; antennæ entirely black. Thorax rather broader than long; sides straight and parallel, converging at the apex; basal margin in front of the scutellum sinuate; disk impunctate, flattened in the ♂, the anterior border broadly thickened; disk deeply and irregularly excavated in the ♀, the apex abruptly elevated and forming a strongly raised transverse ridge; the excavated disk is separated by two short ridges in front into three longitudinal sulcations, one short and apical, the others much broader, lateral, oblique, excurved at the apex, extending the whole length of the excavation, and confluent at the base. Elytra narrowly oblong, nearly parallel, minutely punctured, transversely depressed below the basilar space, the latter slightly thickened; hinder half of disk ventricose.

Megalognatha subcylindrica.

M. elongata, subcylindrica, fulva, nitida, antennis nigris; thorace transverso-quadrato; elytris fortiter sat crebre punctatis, pone medium vix elevatis.

Mas thoracis disco plano, fortiter punctato, margine apicali incrassato, postice angulato; antennis incrassatis, articulis intermediis

difformibus; abdominis segmento apicali late concavo-emarginato.
Fœm. thoracis disco rude rugoso-punctato, pone apicem trifoveolato, apice abrupte elevato, cristam angulatam formante; antennis filiformibus; abdominis segmento ultimo obtuse angulato.
Long. 3 lin.

Hab. South Africa.

Head strongly exserted and porrect in the ♂, less exserted and more deflexed in the ♀; antennæ in the ♀ filiform, the third joint twice the length of the second, rather longer than the fourth; in the ♂ the antennæ are incrassate, the third to the sixth joints obconic, the seventh and eighth irregularly subclavate, the ninth and tenth subtrigonate, and the eleventh cylindrical, its apex acute. Thorax subquadrate; sides straight and parallel from the base to beyond the middle, thence obliquely rounded to the apex, the anterior angles mucronate; upper surface convex on the sides, flattened on the middle disk, strongly but not very closely punctured in the ♂, the apex in the same sex thickened on its middle third, the hinder border of the thickened portion angulate; in the ♀ the disk is coarsely rugose-punctate, and placed transversely just behind the apex are three large deeply excavated foveæ; the apical border is abruptly elevated and forms a strongly raised angular ridge. The elytra are not ventricose behind their middle, but gradually increase in convexity from the base towards the apex; surface sculptured as in *M. ventricosa*.

Megalognatha rufiventre.

M. elongata, nigra, nitida, pectore griseo-sericeo, abdomine rufo; thorace rude punctato, ante apicem profunde transversim excavato, apice abrupte elevato, cristam elevatam formante; elytris subopacis, piceo-nigris, fortiter et crebre punctatis. (*Fœm.*)
Long. 3 lin.

Hab. Lake Nyassa.

Head exserted, subporrect; vertex granulose, impunctate; encarpæ large, well defined, trigonate; carina strongly raised, narrowly wedge-shaped; antennæ filiform. Thorax rather broader than long; sides rounded, the hinder angles acute, the anterior ones mucronate; upper surface deeply punctured, the anterior half of the middle disk nearly covered with a broad, slightly curved, deeply and irregularly excavated transverse sulcation, which does not extend to the lateral margin: immediately in front of this excavation is a strongly raised angulate ridge. Elytra coarsely punctured, gradually increasing in convexity from the base towards the apex.

In the unique specimen in my collection the left antenna is double from the eighth joint.

Chthoneis bivittata.

C. elongata, angustata, parallela, nigra, nitida, antennarum articulis penultimis duobus flavo-albidis; thorace lævi, impunctato, trifoveolato, foveis duabus transversim positis, magnis, profunde impressis, unaque parva ante basin posita; elytris confuse punctatis, piceo-nigris, utrinque vitta lata basi et apice abbreviata, flavo-alba.

Long. 2 lin.

Hab. Brazil, Constancia.

Vertex smooth, impunctate; encarpæ subquadrate; carina narrow, wedge-shaped, its apex very acute; eyes very large, prominent; antennæ equal to the body in length, the second joint very short, the third still shorter than the second, piceous, the fourth to the eighth very slightly compressed, obsoletely dilated. Thorax rather broader than long; sides straight and parallel, slightly converging towards the apex, the anterior angles thickened, obtuse; upper surface transversely convex, impressed with three foveæ, one just in front of the base, small and shallow, and two others, much larger and more deeply excavated, placed transversely on the middle disk. Scutellum trigonate, its apex obtuse. Elytra broader than the thorax, parallel, distinctly punctured, the interspaces granulose, subrugulose. Claws acutely appendiculated.

This species differs from the typical form of the genus by the less dilated and less compressed intermediate joints of the antennæ and by the acutely appendiculated claws.

Chthoneis albicollis.

C. subelongata, nigra, nitida, pedibus (tibiis apice tarsisque exceptis), thorace antennarumque articulis ultimis tribus albidis; thorace transverso, lævi; elytris anguste oblongis, crebre et fortiter punctatis, interspatiis rugulosis.

Long. 2–3 lin.

Hab. Brazil, Petropolis. Collected by Mr. J. Gray.

Vertex smooth, impunctate; encarpæ transversely trigonate, contiguous; carina narrowly wedge-shaped; antennæ longer than the body, the second and third joints very short, equal, the fourth to the eighth compressed and slightly dilated, the ninth to the eleventh cylindrical, filiform, white, the extreme apex of the terminal one black. Thorax more than twice as broad as long; sides slightly rounded; disk smooth, impunctate, impressed on either side with a very shallow ill-defined fovea, only visible when viewed obliquely. Elytra black, with a bluish tinge, coarsely and closely punctured, the interspaces rugulose.

Chthoneïs Grayi.

C. subelongata, nigra, nitida, thorace pedibusque sordide fulvis, tibiis apice, tarsis femoribusque anticis dorso nigro-piceis; thorace transverso, lævi, utrinque foveolato; elytris cæruleo-nigris, fortiter et crebre punctatis, interspatiis rugulosis.
Mas thoracis margine antico medio sinuato; antennarum articulis duobus ultimis (ultimi apice excepto) sordide fulvis.
Fœm. thoracis margine antico medio non sinuato, antennarum articulis tribus ultimis sordide fulvis.
Long. 3–$3\frac{1}{2}$ lin.

Hab. Brazil, Constancia. Collected by Mr. Gray.

Vertex shining, impunctate, lower portion of front, together with the orbit of the eyes, finely strigose; encarpæ contiguous, transversely trigonate; carina narrowly wedged-shaped; antennæ much longer than the body in the ♂, not quite so long but exceeding the body in length in the ♀; the third j ont shorter than the second, transverse and turbinate in the ♂; the second and third joints equal in length in the ♀, the intermediate joints rather less dilated in the latter sex. Thorax more than twice as broad as long; sides in the ♂ diverging from the base to far beyond the middle, then rounded and converging to the apex, the anterior angles thickened, obtuse; in the ♀ the sides are less dilated anteriorly and more regularly rounded; in the ♂ the apical margin is deeply sinuate in its middle third; in the ♀ it is regularly concave for its whole length; disk smooth and shining, impressed on either side with a deep fovea. Elytra sculptured as in *C. albicollis.*

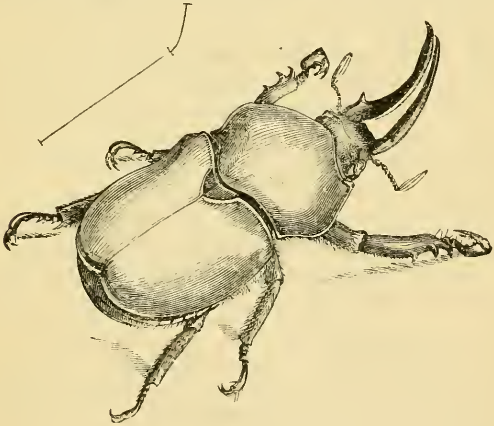
[To be continued.]

XLVII.—*Description of* Didrepanephorus bifalcifer, *the Type of a new Genus and Species of* Rutelidæ, *remarkable for the huge Sickle-shaped Mandibular Horns of the Males.* By J. Wood-Mason, Deputy Superintendent, Indian Museum, Calcutta.

In a rich collection of insects formed amongst the hill-ranges of the N.E. frontier of India, and recently brought to this country by Mr. A. W. Chennell, of the Topographical Survey, I have detected an insect which introduces us to a perfectly novel feature in the morphology of the Lamellicorn beetles. Every zoologist is familiar with the enormous horns which arise from the head or pronotum, and even from both these parts in the same species, in the males of so many members of this great family of Coleopterous insects; but no species have hitherto been described in which the mandibles are the seat of an analogous sexual distinction; nor, indeed, are any known in which these organs project beyond the head to any notable extent: "jamais elles ne dépassent notablement le chaperon en avant," remarks the great systematist * of the Coleoptera, when discussing the mouth-parts of Lamellicornia in general. In this fine new insect, however, the apical one of the two teeth into which, in most of the true Rutelidæ, the extremity of the mandibles is externally divided, is enormously produced and curved forwards far in front of the head, much after the manner of the tusks in several extinct elephants. In *Peperonota Harringtonii*, Westw., its nearest ally, the secondary sexual characters of the males take a different form, the middle of the hinder margin of the pronotum being in this case produced backwards, upwards, and downwards into a huge decurved horn, the extremity of which is lodged in a depression of the suture of the elytra.

I beg to propose for this remarkable form the name of

Didrepanephorus bifalcifer †, gen. et sp. nov.



Body short and thick-set as in *Peperonota* and *Parastasia*. Integument brown, covered with a very short and moderately

* Lacordaire, 'Gen. des Coléoptères,' t. ii. p. 51.

† From δι-, "two," et δρεπανηφόρος, "bearing a sickle" (ἅρμα δρεπανηφόρον, Xen. Anab. I. 10); and *bi-*, "two," et *falcifer*, "bearing a sickle."

dense, somewhat appressed, golden-brown pubescence with a plush-like lustre, especially on the pronotum, where in places it exhibits a tendency to become shaggy. Pronotum gibbous, its posterior margin strongly sinuous, its sides angulate-rotundate, and its anterior margin sinuous, with the lateral angles slightly produced and subacute. Scutellum moderate, broader than long, very slightly overlapped at base by the broadly rounded median lobe of the pronotum, longitudinally roof-shaped, its sides next the elytra very slightly arcuate. Elytra short, leaving the posterior half of the propygidium exposed, constructed much as in *Peperonota*, tolerably thickly but irregularly punctate * between the hairs of the pubescence. Pygidium scarcely visible from above, very convex, its basal two thirds or thereabouts directed straight backwards, the remainder downwards. Abdomen with six visible ventral somites, of which the first four are very short and closely packed, together scarcely exceeding the fifth in length; the first three of them longitudinally somewhat roof-shaped and angularly emarginate in the middle of the hinder margin; the sixth with a rounded emargination in its posterior border, which is incompletely filled by the apex of the pygidium. Mesosternum simple. Prosternum with a slight postcoxal projection.

Fore legs short and very robust; the outer edge of the tibiæ strongly tridentate in characteristic Ruteline fashion; the terminal joint of the tarsi enlarged and strongly curved, with a large, blunt, dark brown tubercle on the inner concave curvature; the penultimate joint produced at the apex to a hard, blunt, dark brown point, against which the enlarged, sharp-edged, and simple outer unguis folds so as to form an efficient prehensile subchela. The four posterior legs much less robust, the intermediate pair as much inferior in robustness to the posterior as these are to the anterior; the outer ungues in all deeply cleft. On all the six femora, along the inner margins of the simple subcylindrical four posteriar tibiæ, and at the free edges of the ventral thoracic somites, the pubescence is developed into long and shaggy light-brown hair.

* Under a 3-inch objective the puncta show themselves as rather large and shallow oval depressions, in the middle of each of which is a small, dark brown papilla with a pore or pit at its summit. Can these perforated papillæ be the mouths of skin-glands, from which an offensive secretion is poured out as a defence?

Since the above was written, I have examined specimens (of both sexes in one case) of the two species of *Peperonota* represented in the national collection; and I find that the elytra in all exhibit a sculpture of the same kind, but differing in matters of detail according to species. In connexion with the above suggestion as to their possible, if not probable, nature, it is a significant fact that none of the papillæ give insertion to hairs.

Epicranium coarsely, irregularly, and not very thickly punctate, a pale brown hair springing from each pit. Clypeus unarmed, inclined to the rest of the head at an angle of about 140°, and limited off from it by a strong sinuous sutural impression, which is broadly concave forwards in the middle, and convex on each side above and behind the mandibles; it has the form of an inverted thick T (⊥), the perpendicular stroke of which is disproportionately short and broad. Labrum salient, transverse, with its lower margin faintly roundly emarginate. The body of the mandibles is enlarged, and the part of them corresponding to the apical one of the two teeth into which, in most true Rutelidæ, their extremity is externally divided, is produced forwards and upwards into enormous, curved, sickle-shaped, horn-like processes, each of which is furnished near the base, on the upper and outer edge, with a short, sharp, and slightly upturned conical tooth, the representative of the basal of the two above-mentioned teeth in an ordinary Rutelide and of the prominent and recurved outer angle of the mandible in *Peperonota*. These huge mandibular horns are somewhat compressed and subtrihedral, and taper gradually to a sharp point, approximating as they go; but they do not meet in the middle line, and are fully a millimetre apart at the apex; like the ungues and the tibial spines of the fore legs, they are of a rich dark (almost black) brown colour, and being, besides, smooth and polished, form a most effective contrast with the light golden brown of the body.

The other gnathites, so far as can be told without extracting them, differ in matters of detail only from those of such Ruteline forms as *Peperonota*, *Antichira*, &c.

Measurements of the typical specimen.

	millim.
Total length, measured between the fore margin of the clypeus and the most prominent part of the pygidium	21
Length of the pronotum	8
Width of ditto	10
Length of the elytra	11
Width of the conjoined elytra between the humeral angles	10·25
Length of the mandibular horns along the convex curvature	11
Length of the fore femora	4·75
„ of the fore tibiæ	5·5
„ of intermediate femora	5·25
„ of intermediate tibiæ	4·75
„ of posterior femora	5·5

		millim.
Length of posterior tibiæ		4·5
Width of the head between the outer margin of the canthi of the eyes		5·5
Length of the clypeus		2·5
,, of scutellum		2
Width of ditto at base		3
Length of antennal club		2·25

Three specimens of this fine and remarkable addition to the Coleopterous fauna of India were discovered by Mr. M. J. Ogle, of the Topographical Survey of India, in one spot near Wakidgaon, a village 30–35 miles S.E. of Sadia, in the valley of the Noa Dehing, a feeder of the Brahmaputra. They do not differ from one another in the smallest particular, and, as each presents the same modification of the fore tarsi as that by which males are distinguished from females in such Rutelidæ as *Antichira lucida*, are doubtless all males.

A more detailed and formal description, with figures of the mouth-parts, is to be published hereafter elsewhere.

MISCELLANEOUS.

The Nauplius *Stage of Prawns.*

Blumenau, St. Catharina, Brazil.
Sept. 11, 1878.

My dear Sir,—I duly received a few days ago, and heartily thank you for, a copy of your paper "On the *Nauplius* Stage of Prawns." As soon as I can find time to do so I shall discuss this question once more, though I am unable to give new facts; for I have been living far from the sea for more than eleven years.

I hope you received a copy of the German original, translated in the 'Annals,' which I sent you some months ago.

The main object of my writing you to-day is to beg you to compare the translation of my paper in the 'Annals' with the German original, in order to convince yourself that I did not use the word "opponents," which has been added by the translator. Indeed, "let my opponents tell me," is not a very exact translation of the words I used—"so sage man mir"*. I, as well as you, have always thought

* [The word "opponents" does not occur in the translation of Dr. Fritz Müller's paper published in this Journal for June 1878 (p. 484), but in Mr. Spence Bate's quoted translation of the same passage ('Annals,' July 1878, p. 80). To us the whole question of the expression used seems to be of little consequence: the people whom Dr. Müller asks to tell him something are those who hold an opinion opposed to his own; and if these are not "opponents," "so sage man uns" what they are.—Eds.]

that "the only object that any truly sincere observer can have is to establish the truth."

Since I left the sea-shore I have made extremely few carcinological observations. Our freshwater crustaceans are not numerous. There are a few crabs, some prawns (*Palæmon*), among them a large *Macrobrachium* and a genus allied to *Atya*, and two species of *Æglea*. One of the species of *Æglea* is rather common in the small rivers of the Serra (about 1000 metres above the level of the sea); this species is very frequently infested by that curious parasitical worm *Temnocephala*, which Claude Gay discovered on the crustaceans of Chili.

I do not know whether you may be interested in any of the objects to which I have devoted my time during the last ten years—heterostyled and self-sterile plants, termites, honey-bees (*Melipona* and *Trigona*), butterflies, &c. At present I am collecting and observing the larvæ of our caddis flies, some of which construct very curious cases, quite different from those of the European species.

Believe me, dear Sir, with sincere respect,

Very faithfully yours,

Mr. C. Spence Bate. FRITZ MÜLLER.

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

GENTLEMEN,—Will you, in reply to Mons. Giard's remark in the September number of your magazine, that I have endeavoured to prove that "the *Nauplius* described by Fritz Müller as belonging to *Penæus* cannot be the young of any prawn," permit me to say that I have only attempted to show that, as far as our knowledge extends, it has not been proved to be so.

I regret that I should have omitted doing justice to M. Giard's communication on the embryogeny of the Rhizocephala; but I regret to say that I had not previously seen the paper, neither does it appear to have been noticed in the 'Zoological Record' for 1874.

Yours obediently,

Oct. 16, 1878. C. SPENCE BATE.

Amphipoda in Sponges.
By the Rev. T. R. R. STEBBING, M.A.

In the interesting paper by Mr. H. J. Carter, F.R.S. ('Annals,' Aug. 1878), on the various creatures that find a home in sponges, certain Amphipods are mentioned. The list of these may be enlarged. There are two species which I have taken in sponges and in sponges only, namely *Exunguia stilipes* (Norman), which is in all probability the same as *Cratippus tenuipes* (Spence Bate), and *Atylus gibbosus* (Spence Bate). Of *Leucothoë articulosa* (Leach), which can often be obtained by dredging, I once found several fine specimens in a sponge cast up on the shore at Worthing; and on one occasion at Torquay I found numerous specimens of *Podocerus pelagicus* (Spence Bate) in the *Halichondria panicea* in which I was searching for *Exunguia stilipes*. The Rev. A. M. Norman, in his British-Association Report (1868) of dredging among the Shetland Isles (see also Report for 1867), mentions *Anonyx tumidus* (Kröyer) as sometimes occupying the branchial sac of an Ascidian, and sometimes making a sponge its habitat. He also speaks of *Caprella linearis* (Linn.) as very abundant in Halse Hellyer, Burrafirth, among *Tubularia indivisa* and sponges, and of *Caprella lobata* (Müller) as being with the last, but scarce. Of *Atylus gibbosus* he observes that it appears to live constantly parasitic in sponges, in accordance with what has since been my own experience of its habits. It would have been better, I now think, to have referred *Dexamine antarctica*, mentioned in Mr. Carter's paper, to the closely allied genus *Atylus*, both on account of its agreement with *A. gibbosus* in the choice of a sponge for its residence, and on account of its having, like that species, the metacarpus of exceptional length in all the pereiopoda.

On the Oviposition of the Queen Bee and Dzierzon's Theory. By M. J. Pérez.

According to a classical theory, which had its birth in Germany and which no one now-a-days disputes, a fecundated egg of the queen bee is a female egg, and all unfecundated eggs are male. The mother bee, it is said, can even lay at will an egg of one or the other sex. This faculty, which is exceptional in the animal kingdom, is explained by assuming that the bee, at the moment of the passage of the egg into the oviduct, can apply to it or not a certain quantity of the seminal fluid contained in the seminal receptacle. Nevertheless the organization of the generative apparatus of the bee does not differ essentially from that of the majority of female insects, to which no one has ever thought of ascribing the power of acting at pleasure upon phenomena which seem to be absolutely removed from the influence of the will.

The hypothesis was set up mainly to explain the fact, which has hitherto not been disputed, that an Italian female fecundated by a German male furnishes hybrid females (workers and queens) and pure Italian males. The opposite would be the case if a German queen were fecundated by an Italian male: so that a male egg would never receive the seminal baptism; a drone would never have a father.

Now I possess at this moment a hive, the queen of which, the daughter of an Italian of pure race, has been fecundated by a French male. The workers, in fact, are partly true Italians, others French, whilst others present a mixture, in various proportions, of the characters of the two races.

Being surprised to see in this hive certain drones, amongst others, as dark as French males, when, according to the theory, all ought to have been Italians like their mother, I thought it necessary to examine these males more closely. I therefore collected 300 of them and examined them most carefully, obtaining the following statistics :—

151 were pure Italians.
66 were hybrids in different degrees.
83 were French.

From this it is evident that the drone eggs, like those of the females, receive the contact of the semen deposited by the male in the female organs ; and the theory of Dzierzon, proposed to explain an insufficiently ascertained fact, becomes useless if this fact is disproved.

It is easy to understand how an insufficient observation may have led to the belief that the drones, the sons of an Italian mother fecundated by a male of a different race, were all Italians. Of 300 males only 83 appeared to me to be strictly French, while 151 + 66 or 217, *i. e.* the great majority, being yellower than the French drones, might easily pass for pure Italians. Thus, in such cases, if a great number of males in a hybrid hive have not been carefully examined one by one, it is easy to understand how it might be believed that they all belonged to the same race as their mother, especially when the latter belongs to the handsomer and yellower race.—*Comptes Rendus*, September 9, 1878, p. 408.

On the Cause of Buzzing in Insects. By M. Jousset de Bellesme.

Referring to the paper on this subject by M. Pérez, an abstract of which appeared in the last number of this Journal, M. Jousset de Bellesme has laid before the Academy of Sciences a statement of the results arrived at by him, and communicated on August 23 to the "Congrès pour l'Avancement des Sciences." He says :—

All insects in which the rapidity of vibration of the wing is above eighty vibrations [per second?] emit a perceptible sound provided their wing-surface is sufficiently extensive. The suppression of the wings does away with this sound.

The insects belonging to the orders Diptera and Hymenoptera alone have the faculty of emitting two sounds—that just mentioned, which is deep, and another, sharp sound, generally the octave of the former. This faculty is the essential characteristic of buzzing. When the wings are cut off a *Volucella* or a Humble-bee the deep sound is abolished, but the sharp sound persists ; the deep sound is therefore produced by the wing, while the sharp sound is independent of it.

Landois's opinion, according to which the sharp sound is due to the issuing of the air through the stigmata and the vibration of the valvules with which these are provided, is not tenable, seeing that if these apertures are stopped with bird-lime the sharp sound continues to be produced with the same intensity.

Its origin must be sought in the mechanism by which the wing is set in motion. In buzzing insects the muscles of flight are not inserted directly upon the wing, but upon the pieces of the thorax which carry it. It is the movement of these that moves the wing and makes it vibrate. The thorax therefore undergoes alternate and incessant changes of form under the influence of the contraction of the motor muscles of the wing: in repose a section of this region represents an ellipse elongated vertically; muscular action transforms it into an ellipse elongated laterally. The entire thorax therefore vibrates successively in the direction of its two diameters. As the muscular masses are very powerful, this vibratory movement is very intense, as we may easily ascertain by holding between the fingers a Humble-bee with its wings cut off, but which still seeks to fly away. The thorax consequently forms a vibrating body, which directly concusses the surrounding air, just in the same way as the branch of a diapason for example. In the insects in question the vibrations are repeated a great number of times per second, and there is produced a musical sound which is nothing but the sharp sound characteristic of buzzing. Large insects produce the sharp sound with more intensity than small ones, because the vibrating surface of the thorax in contact with the air is more extensive.

If the thoracic sound, after the cutting away of the wings, is higher than the sound produced directly by the movement of the latter, this is because, during flight the resistance of the air moderates the velocity of contraction of the muscles; while, when the wings are suppressed, the muscles, vibrating without producing any useful effect, attain their maximum velocity.

After the removal of the wings, by attaching a style to the upper wall of the thorax, we may directly inscribe its vibrations; and in this way I obtained traces in which the number of vibrations corresponds exactly to the height of the sharp sound perceived by the ear. There can therefore be no doubt as to the thoracic origin of this sound.

Buzzing occurs only in the Hymenoptera and Diptera, because it is only in these insects that the deformation of the thorax by the action of the muscles of flight takes place over a surface sufficiently extensive to produce a perceptible sound.—*Comptes Rendus*, Oct. 7, 1878, p. 535.

On the Ascarides *of the Seals and Toothed Whales.* By Dr. H. Krabbe.

Professor Leuckart's notice * of an Ascarid voided by a child in Greenland, which he described under the name of *Ascaris maritima*, and supposed to have probably belonged to a seal or some other

* Die menschlichen Parasiten, Bd. ii. 1876, p. 877.

Greenland mammal, led the author to examine the collection of *Ascarides* in the University Museum at Copenhagen, where he found about forty bottles of these worms obtained from seals, and about twenty bottles of specimens derived from toothed whales.

I. *Ascarides from Seals.*

O. Fabricius* enumerates three species of *Ascarides* in Greenland seals, namely *Ascaris phocæ, bifida*, and *tubifera*; but his descriptions are insufficient. Rudolphi † described the worm that he had the opportunity of examining under the name of *A. osculata*; and this was identified by Schneider with an *Ascaris* from *Phoca grœnlandica*, which he fully described. Baird ‡ described *Ascaris similis* from an antarctic seal, but not sufficiently for the distinction of the species.

The forty bottles of *Ascarides* from seals, mostly from Greenland, in the museum contained a mixture of two different species, which, however, could hardly be distinguished by the naked eye.

1. *Ascaris osculata*, Rud., occurred in twenty-three collections, as follows:—from *Phoca grœnlandica* (10) from Greenland and Iceland; *P. barbata* (2) from Greenland; *Halichœrus grypus* (3), no locality recorded; *Cystophora cristata* (1) from Greenland; and *Trichechus rosmarus* (2) from Greenland; and also (5) from unnamed seals at the Færöe Islands, Iceland, and Greenland. The number of worms in an individual seal amounted sometimes to 200 or 300. The proportion of males to females was about as two to three. The females attain a length of 80 millims. and the males of 60 millims. The red streak observed by Schneider at the base of the lips is not constant; the author never found it.

2. *Ascaris decipiens*, sp. n. This worm belongs to Schneider's first group, which also includes *A. maritima*, and in which the lips are denticulate and there is no intermediate lip. The lips, which are nearly equal, have in front a pair of broad rounded lobes, directed obliquely sideways, separated on each side by a notch from the rest of the lip; the teeth form three arched lines, one in the middle and one on each lobe. Of the caudal papillæ of the male the three hindmost are conical and diminish in length posteriorly; they are followed by three short processes on each side behind the anus. Those before the anus increase in length to the seventh or eighth and are arranged in a single row.

This species occurred in twenty-one collections—from *Phoca grœnlandica* (4), *P. barbata* (4), *P. hispida* (1), *P. vitulina* (6), *Cystophora cristata* (1), and *Trichechus rosmarus* (1), all from Greenland: and also in three unnamed seals from the Færöe Islands, Iceland, and Greenland. The species has also been found in a *Phoca vitulina* from the west coast of Slesvig. In one collection the number of worms was about 200, in the proportion of one male

* Fauna Grœnlandica, 1780, p. 272.

† Wiedemann's Archiv, Bd. ii. St. 1 (1801).

‡ Catalogue of Species of Entozoa, 1853, p. 19.

to two females. The length of the females about 60, of the males about 45 millims.

II. *Ascarides from Toothed Whales.*

Of these Schneider only describes *Ascaris lobulata*, found in *Platanista gangetica*. It belongs to the same group as *A. osculata*. Rudolphi described *A. simplex* from *Phocæna communis*; and Dujardin refers to the same species a worm from a dolphin taken near the Maldive Islands. The twenty bottles in the University Museum contain three species:—

1. *Ascaris lobulata*, Schn., from the buccal cavity of a Gangetic dolphin in the Hooghly.

2. *Ascaris simplex*, Rud. To this species the author refers all the *Ascarides* obtained from toothed whales and dolphins on the coasts of Denmark, the Færöes, and Greenland, namely:—from *Lagenorhynchus albirostris* (2), Denmark; *Beluga leucas* (7), Greenland; *Hyperoodon rostratus* (1), Færöes; and *Monodon monoceros* (3), Greenland. 177 individuals occurred in one whitefish, in the proportion of one male to two females. The latter reached 200, the males 130 millims. in length.

This worm belongs to Schneider's first group. The lips are very similar, and have in front a pair of lobes separated from the rest of the lip by a sinuosity; on the inner side of the lobes there is an armature of teeth. Of the caudal papillæ of the male the four nearest the apex are conical and arranged in pairs, the outer one of each pair being the longest. Close behind the anus are two short papillæ on each side, or sometimes only one large one; and on each side of the anus there is a group of six short papillæ.

Ascaris angulivalvis, Crepl., the only species described from a whalebone-whale, was obtained at Bergen by Koren from *Balænoptera rostrata*. The author finds that it is identical with *A. simplex*.

3. *Ascaris conocephalus*, sp. n. This species was described by Diesing under the name of *Conocephalus typicus*; but the hood in front of the mouth described and figured by him does not belong to the worm, but is composed of coagulated mucus or of portions of the intestinal epithelium of the dolphin in which it was found. It has been obtained in great numbers, usually from the stomach of dolphins, from various parts of the Atlantic between Africa and America. Of 370 individuals in our collection about half were males. Females 90, males 70 millims. long.

This species is nearly allied to *A. simplex*. The labial lobes, which are armed with teeth, are narrower and separated by a deeper notch from the rest of the lip. Of the papillæ in the male three, or sometimes only two, of the hindmost are conical; close behind the anus there is on each side a group of seven short papillæ. The other papillæ are arranged in three well-marked rows, but they become smaller and less regular towards the anus.—*Oversigt af Kongl. Danske Vidensk. Selsk. Forhandl.* i Aaret, 1878, pp. 43–51.

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XLVIII.—*New Hydroida from Ochotsk, Kamtschatka, and other Parts of the North Pacific Ocean.* By C. MERESCHKOWSKY.

[Plates XVI. & XVII.]

THERE exists a very fine collection of Hydroids from the northern parts of the Pacific Ocean—from Kamtschatka, the sea of Ochotsk, the Aleutian Islands, and our former possessions in North America. This collection, which belongs to the Academy of Sciences of St. Petersburg, has been brought together at different times and by different persons, but especially by Middendorff and Wosnessensky. It is in the form of a herbarium, all the specimens being dried; but in other respects its condition is very good, although, certainly, delicate species, such as the Campanulariidæ and all the Athecata, can no longer be investigated.

Dr. A. Brandt, conservator of the Zoological Museum of the Academy, has had the kindness, for which I have to thank him, to lend me this collection for examination; and in this article it is my intention to describe some new species which I have met with in it, and which are not without interest*. I shall commence with the genus which I not long since named *Polyserias*.

* Short diagnoses of all these species have already been published in Russian in the Transactions of the Society of Naturalists of St. Petersburg, vol. ix.

Selaginopsis (=Polyserias).

Since my article on this genus in the 'Annals,' and a short note on the same subject published a little later*, I have had the opportunity of seeing the interesting article by Mr. Allman† on new Hydroids from various countries, in which, among other things, that gentleman describes two new genera, *Selaginopsis* and *Pericladium*. As may be seen from the diagnoses and descriptions that he gives of the species of these two genera, the second differs from the first only "in the disposition of its hydrothecæ in longitudinal series, as well as in its totally different type of ramification"‡. The Rev. A. M. Norman §, who has added some species to the genus *Selaginopsis*, accepts it in the same sense as Mr. Allman has done, and separates it from the genus *Pericladium*. Now it is certain from the species that I have been able to examine, some of which have been described by me, whilst others will be described in the present paper, that neither from the arrangement of the hydrothecæ, nor from the mode of ramification, is it possible to separate the two genera from each other, but, on the contrary, we find ourselves compelled to unite them in a single one, in the sense in which the genus *Polyserias* was established by me. As regards the different form of ramification I may remark at once that *Pericladium bidentatum*, for example, differs essentially from *Selaginopsis mirabilis*, one having ramifications in all planes, as in *Thujaria thuja*, and the other having them only in one plane; but as to the form and arrangement of the hydrothecæ they resemble one another to such a degree that it would be purely artificial to separate them into two different genera. As regards the arrangement of the hydrothecæ "in longitudinal series," this character is common to both genera; and, in fact, the diagnosis of the genus *Selaginopsis* might be accepted without the least alteration for *Pericladium*, and *vice versâ*.

It is therefore evidently useless to continue to distinguish these two genera, which I propose to unite into a single one, to which I propose to give the name of *Selaginopsis*, as the first described by Mr. Allman, and the one which has been most employed. I will therefore pass to the description of the species which I have examined.

* Ann. & Mag. Nat. Hist. ser. v. vol. i. April and May, 1878.
† Journ. Linn. Soc. vol. xii. (1876), p. 251.
‡ Ibid. p. 272.
§ Ann. & Mag. Nat. Hist. ser. 5, vol. i. March 1878.

1. *Selaginopsis triserialis*, sp. n. (Pl. XVI. figs. 1, 2.)

Trophosome. Hydrocaulus straight, not angularly bent, broader than the branches. Branches arranged alternately and subspirally, springing from all sides, diminishing towards the apex, and ramifying several times. The hydrothecæ, almost entirely immersed in the axial tube and of a cylindrical form, a little narrowed towards the orifice (which is oval with two angles), are placed in three longitudinal series.

Gonosome. Not known.

Locality. Kamtschatka (*M. Kastelsky*).

This small species, which comes from Kamtschatka, is represented in the Academy's collection by only a single specimen (Pl. XVI. fig. 1), 37 millims. long. The lower extremity of the stem, with a small disciform enlargement, was not fixed to any object. The general form of the colony is conical; it diminishes very gradually, so that at its apex it is more or less pointed. The stem is straight, divided into internodes, each having from two to four branches, and bears annulations at its base. The branches, which are arranged on all sides of the principal stem, are excessively slender compared with those of all the other species of this genus, which is explained by the small number of series (three) in which the hydrothecæ are arranged; they are placed at an acute angle to the principal stem, and become shorter and shorter as they approach the apex; they may divide in their turn, usually two or three times, rarely more. The hydrothecæ are arranged in three regular series (Pl. XVI. fig. 2), and in such a manner that no two orifices of the three series come at the same level; this character of the arrangement of the hydrothecæ in three series is perfectly constant in the species in question. The hydrothecæ are almost entirely immersed in the axial tube, to which they are adnate; their orifices, which are compressed, oval, and furnished with two angles, alone project more or less, but in all cases very slightly, from the surface. The two angles are always distinct, although they are not produced into two distinct teeth as, for example, in *Selaginopsis mirabilis*. The form of the hydrothecæ is more or less cylindrical, narrowing a little towards the upper extremity. A small tube with its margins slightly reverted establishes the communication between the cavity of the hydrotheca and that of the axial tube, in the same manner as is described by me in *Selaginopsis Hincksii*, mihi.

Width of a branch 0·55 millim.; length of a hydrotheca 0·45, its maximum breadth 0·25.

This is a very characteristic species, and may be easily recognized by the triserial arrangement of its hydrothecæ, which produces the extreme fineness of its branches. In the mode of its ramification and the form of its hydrothecæ it does not differ greatly from the other species. As all the other species have 4, 6, 8, or more longitudinal series of hydrothecæ, *Selaginopsis triserialis*, having only three, must consequently be regarded as the simplest form.

It might be supposed that the number of series in the polyserial type had originated from the biserial type by the displacement of the hydrothecæ in the two series alternately to one side and the other, which would produce the division of one series into two, as indicated by *Selaginopsis fusca*, Norm., and *S. Allmani*, Norm., in which the series are arranged in pairs—which would be the most plausible and natural explanation. Unfortunately *Selaginopsis triserialis* only serves to throw the question into confusion; for this species can by no means be explained as having originated from the biserial type.

2. *Selaginopsis pinnata*, sp. n. (Pl. XVI. figs. 3, 4.)

Trophosome. Hydrorhiza in the form of a thin and continuous layer, not composed of hydrophytons. Hydrocaulus simple, straight, not angularly bent, annulated at the base, divided into regular internodes. Branches pinnate, straight, springing alternately from two sides, not divided into internodes. Hydrothecæ arranged in *four* regular series, almost entirely immersed in the tubular axis; they do not follow one another immediately in the same series, but leave a certain interval between them. Their form is cylindrical, a little narrowed at the end, with a very short neck, springing outward from the axis; aperture oval, very slightly angular at the two sides.

Gonosome. Unknown.

Locality. Port Ajan (*M. Wosnessensky*, 1848).

The hydrorhiza is formed by a thin layer covered with perisarc (Pl. XVI. fig. 3, *per*), and not composed of tubes united together, as described by me in *Sertularia albimaris*; here, on the contrary, the perisarc is continuous, covering, on shells, spaces sometimes of more than a square centimetre. The hydrocaulus is erect, stout, cylindrical, very long, divided into regular internodes about 8 millims. in length, broader than the branches; its colour is a darkish brown, becoming lighter towards the end, where the branches commence, which are also light brown. Usually only one half or one third, or sometimes even one fourth, of the stem is covered with branches, all the rest being entirely destitute of them (Pl. XVI.

fig. 3). The colony is regularly pinnate; the branches, springing at an acute angle, are arranged alternately; they are of moderate length, and only diminish towards the extremity. Usually each internode bears three pairs of branches. The branches are cylindrical, straight, with their surface smooth (which distinguishes them from those of *Selaginopsis mirabilis*), uniting with the hydrocaulus by a short constriction; their colour is of a very light brown, never becoming darker towards the end, as is always the case in *S. mirabilis*. Sometimes, although very rarely, a branch gives origin to a secondary branchlet near its extremity.

The hydrothecæ are arranged in two series upon the principal stem, and in four regular longitudinal series upon the branches; and this character is perfectly constant (Pl. XVI. fig. 4). Their form is not very characteristic; the hinder part, which is the widest, is rounded, and communicates with the tubular axis by a small tube with the margins slightly reverted. A little neck in the form of a very short tube is placed vertically to the surface of the stem and turned outwards; it terminates in an aperture, which is large, oval, and usually furnished with two angles, which, however, are scarcely, if at all, produced into teeth, as also in *Selaginopsis triserialis*; but here it sometimes happens that there is no angle and the orifice appears regularly oval or even round.

Length of the largest individual 180 millims. (it is therefore one of the largest species); breadth of the colony about from 30 to 35; length of the branches usually 20, sometimes 25; breadth of the hydrothecæ 0·27, of all the branches 0·5; length of the hydrothecæ 0·5; diameter of the aperture 0·14.

This fine species is represented in the collection of the Museum by several large specimens attached to fragments of *Modiola modiolus*; it most nearly approaches *Selaginopsis Hincksii*, mihi, by its mode of ramification, the fact that the surface of the branches is smooth, and the form of its hydrothecæ. But it differs therefrom essentially by its four series of hydrothecæ (*S. Hincksii* always has six), as also by the smaller length and breadth of its branches. At present I know five species of this genus which have colonies of a plumose form—namely, *S. mirabilis*, Verr., *S. Hincksii*, mihi, *S. Allmani*, Norm., *S. fusca*, Johnst., and *S. pinnata*, mihi; all the other species have branches springing not from two sides only of the principal stem, but from all sides, thus affecting a habit quite different from that of the above five species.

3. *Selaginopsis pacifica*, sp. n. (Pl. XVI. figs. 5–7.)

Trophosome. Hydrocaulus slightly curved, divided into regular internodes. Branches arranged alternately *on two sides of the principal stem*, two pairs on each internode, divided into five internodes, constricted at the point of attachment and at the internodes. Each branch bears one or two, rarely five, secondary branches. Hydrothecæ cylindrical, almost entirely immersed in the substance of the axial tube; aperture oval, with two angles (not teeth); hydrothecæ arranged *in four regular series*, and at the same time in a spiral, the hydrothecæ of each series following one another immediately without leaving any free space or interval.

Gonosome. Gonangia arranged in two or three series, of an oval form, narrowing gradually towards the base, and truncate at the apex. The surface is ribbed.

Locality. Metschigman Bay.

The hydrocaulus of this species, in the two specimens possessed by the Academy of Sciences, is not straight, but elegantly curved (Pl. XVI. fig. 5), which may be a constant character. The whole colony is of a light greyish-yellow colour, and, owing to the subdivision of the branches into secondary branches, it acquires a tufted character, which, however, is not produced by division in several planes; on the contrary, both the primary and secondary branches all originate in the same plane. The branches, moreover, become gradually shorter as they approach the apex. The branches usually have a strong constriction in the middle, so that the two internodes thus produced are united only by means of a very slender piece. The hydrothecæ are always arranged in four regular series (Pl. XVI. fig. 6); and it is only very rarely that we meet with a small branch having only three series, as in *Selaginopsis triserialis*. The hydrothecæ are cylindrical, rounded at their posterior part, which is furnished with a small tube to communicate with the cavity of the cylindrical axis. The orifice is oval, furnished with two angles (which, however, are never developed into teeth), and placed at the extremity of a small neck in the form of a very short tube. No two orifices of the four series of hydrothecæ are ever situated at the same level; in other words, we find a very evident spiral arrangement around the cylindrical axis, a character which, as will be shown, appears to be common to the whole genus. It must also be remarked that the hydrothecæ of each series follow each other almost always without interruption and without leaving any interval; on the contrary a part of the superior hydrotheca is covered by the little neck of the hydrotheca following it inferiorly, and it is rare to see a little space between them, whilst in the preceding species the interval always exists.

The gonophores (Pl. XVI. fig. 7) are in great numbers, oval, ribbed on the surface, furnished with a round aperture placed at the extremity of a very small cylinder; they are arranged in three series.

Length of the colony about 60 millims.; width of a branch 0·6; length of the hydrothecæ 0·5, their breadth 0·27; length of the gonangia 1·2, their breadth 0·55.

This pretty species is most nearly related to *Selaginopsis pinnata*, from which, however, it differs in habit, in the mode of ramification and, especially, the subdivision of the branches, as also in the absence of intervals between the hydrothecæ which follow each other in the same series.

4. *Selaginopsis thuja*, sp. n. (Pl. XVI. figs. 8–10.)

Trophosome. Hydrocaulus straight, angular, spiral, divided into internodes bearing branches which spring *from all sides of the principal stem* and are attached by means of a tubular process of the latter. Each branch divides at a certain distance from the point of attachment into two, each of which subdivides again into three branchlets, thus forming a *complex of six branches.* Hydrothecæ more or less conical, broad and round at the base, a little narrowed at the apex, *arranged in six or seven series.* Aperture without teeth or angles, round or oval.

Gonosome. Gonophores sparse, oval, truncate at the apex, and narrowing gradually to the base.

Locality. Northern Pacific Ocean.

In habit this species (Pl. XVI. fig. 8) is just like *Thujaria thuja.* The whole colony is cylindrical, only a little narrowed towards the apex. The hydrocaulus is divided into regular internodes by deep annulations, and bears on all sides short tubes, spirally arranged, to which the branches are attached. Each branch (Pl. XVI. fig. 9) divides only at a certain distance from its point of attachment, which is very characteristic of this species, and distinguishes it from *Selaginopsis decemserialis*, to which we shall refer hereafter. The branch first of all divides dichotomously into two parts, each of which is in its turn formed by three small branches nearly of equal length. Width of the branches moderate. Colour greyish brown; that of the principal stem dark brown. The hydrothecæ are arranged in several series, the number of which is not constant; but usually a branch has five series at its base, then six, and finally seven series at its extremity; and I have very rarely met with cases in which the end of the branch had fewer than seven series. The form of the hydrothecæ is not cylindrical as in most species of the genus, but more or less conical (Pl. XVI. fig. 10) and rather elongate; this last character, however, is not very constant, and occasionally we meet with hydrothecæ having the ordinary, more or less cylindrical form. The aperture is oval or round, without any trace of teeth or even of angles. The hydrothecæ of each series are arranged so as to leave small intervals between them. The gonosome has nothing very characteristic about it, and scarcely differs in any way from the normal form; that is to say, it is oval, truncate above, and narrowed below.

Length of the entire colony 75 millims., breadth 15; width of the branches 0·7; length of hydrothecæ 0·45, maximum breadth 0·25; length of gonothecæ 0·7, their width 0·5.

The Academy of Sciences of St. Petersburg only possesses a single specimen of this species, the ticket belonging to which has been lost, so that the only locality I am able to give is the Northern Pacific Ocean; but it is very probable that the species comes from the sea of Ochotsk or from Kamtschatka. *Selaginopsis thuja* is distinguished by its mode of ramification (six branches), by the form of the colony, and by the form of the hydrothecæ and their arrangement in six or seven series.

5. *Selaginopsis ochotensis*, sp. n. (Pl. XVI. figs. 11, 12.)

Trophosome. Hydrocaulus straight, angular, bearing branches on all sides, which are attached by means of a cylindrical tube springing from the stem. Each branch divides at some distance from the point of attachment into *six* long and broad branchlets. Hydrothecæ arranged in several regular series, *most frequently in eight or nine*, and at the same time spirally; they are not entirely immersed in the substance of the axial tube, but their ends project. Aperture compressed, furnished with two large teeth.

Gonosome. Gonangia arranged *along the whole length* of the branches, pyriform, with a straight, not bent neck, and with the surface smooth.

Locality. Sea of Ochotsk (*M. Djuktshandran*, 1844).

This species, of which the Museum of the Academy possesses two specimens, is very characteristic, and quite distinct from all the others that I have just described. The hydrocaulus is broad and angular, and bears branches on all sides in such a fashion as to form in the whole the habit of *Thujaria thuja*, but much more robust than the latter in consequence of the greater breadth of the branches. At the apex of the colony the branches become a little shorter (Pl. XVI. fig. 11). The colour is a rather light brown. Each branch divides at a certain distance from its point of attachment at first into two; and then each half is again subdivided into three, thus forming a complex of six small branches (Pl. XVI. fig. 12). The hydrothecæ are just the same as in *Selaginopsis mirabilis*, Verr., with the same two teeth, and the neck projecting strongly outwards, giving an uneven appearance to the surface of the branches. The branches are uniform throughout their length, equally arranged, and are not divided into internodes as in *S. bidentata*, Allm. * The gonangia also are arranged on the *whole* length of the branches, and not merely upon a single internode (the first or inner one) as in the species just mentioned. The gonangia (Pl. XVI. fig. 12 *a*) differ from those of *S. bidentata* in not being curved at the basal part, and in being quite smooth (not ribbed) on the surface. Their form is a little variable; and as they are very numerous on the branches and pressed close together, it often happens that they are a little deformed and more or less flattened by pressure.

Length of the entire colony 125 millims., its width 25; length of hydrotheca 0·45, its breadth 0·3; length of the gonophore 1·3, its breadth 0·7; width of a branch 0·8.

This species is very well distinguished from *Selaginopsis mirabilis*, Verr., by the general form of the colony, and by the arrangement of the branches on all sides of the stem, as also by the greater number of the series of hydrothecæ, which varies from eight to ten, being generally eight or nine, whilst *S. mirabilis* has constantly only six. From *Selaginopsis bidentata*, Allm., its nearest relative, it is distinguished by the absence of any special part of the branches destined to bear the gonangia and separated by a transversejoint, also by the more tufted habit of the whole colony †, by the six branches united in each group, while *S. bidentata* has only four (which, in fact, causes the less tufted habit of the colony), and, lastly, by the form of the gonangia. The two species are very nearly allied, although it is impossible to unite them under a single one. It would be desirable to know exactly the number of series in which the hydrothecæ are arranged in *S. bidentata*; for Mr. Allman does not state the number. To judge from the figure there seems to be in this respect no difference between the two species. As to the arrangement of the hydrothecæ in "verticils," this term cannot be regarded as correct; for in reality

* Journ. Linn. Soc. 1876, vol. xii. p. 273 (*Pericladium bidentatum*), pl. xx. fig. 2.

† Allman, *l. c.* fig. 1, and my fig. 11, Pl. XVI.

neither in *S. bidentata* and *ochotensis*, nor in any other species belonging to the genus, do we ever see a truly verticillate arrangement (we can observe only an arrangement in longitudinal series and in a spiral); on the contrary, it may be asserted of this genus that no orifice of a hydrotheca is ever placed at the same level as another.

6. *Selaginopsis decemserialis*, sp. n. (Pl. XVII. figs. 13–16.)

Trophosome. Hydrocaulus straight, cylindrical, very thick, angularly bent, divided into internodes. Branches springing from all sides by three together, dividing at the very point of their attachment, united with the stem by means of a little tube; straight, simple, cylindrical, becoming shorter towards the apex. Hydrothecæ large, cylindrical, with an oval aperture, entirely immersed in the substance of the axial tube, arranged in *ten* regular longitudinal series, and forming at the same time a spiral round the axis.

Gonosome. Gonangia arranged in several longitudinal series, more or less cylindrical, narrowed at the base, and furnished with a wide and short cylindrical elevation at the apex, most frequently turned inwards.

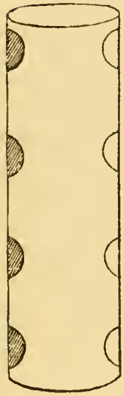
Locality. Northern Pacific Ocean (shore of Pallana, *M. Wosnessensky*, 1849).

This interesting species belongs to the type of *Selaginopsis* affecting more or less the general aspect of *Thujaria thuja*. In *S. decemserialis* this habit is exactly reproduced, especially in a variety of the species which I have figured Pl. XVII. fig. 13. This variety differs from the normal type by its branches being shorter, and not diminishing as they advance towards the apex, which is also the case in *Thujaria thuja*, and causes the general form of the colony to be cylindrical; whilst the normal form has the apical branches only one half or one third the length of the lower ones, although of the same thickness, producing a general conical form of the colony. The hydrocaulus is long and destitute of branches for the greater part of its length (just as in *Thujaria thuja*); it is angular; and each angle bears a short but wide tube, which serves as a base for three united branches. The mode of ramification of the branches is very consistent in the different species. As we have seen, in *Selaginopsis thuja* and *S. ochotensis* the branches subdivide into six parts, and not from their actual point of attachment, but at a certain distance therefrom; while here there are always only three small branches, and they unite at the very point of their attachment (Pl. XVII. fig. 14).

Sometimes in this species we see the principal stem divide into two, and each half bear at its extremity a fresh series of branches, a new colony. The hydrothecæ are arranged in ten regular series; but this character is not perfectly constant; sometimes, although rarely, we meet with very slender branches which have only seven or eight series; and, further, the number ten appears to be most constant at the ends of the branches, where it is almost always met with; whilst towards the point of attachment the number very often diminishes, becoming nine, eight, and sometimes seven, or even six. The great number of series causes the branches to be very thick; in this species they attain the greatest thickness that I know.

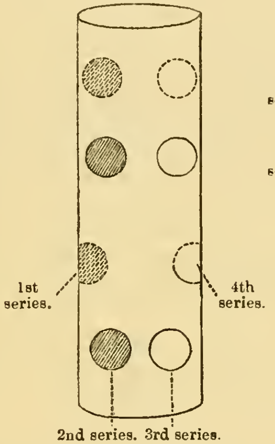
The hydrothecæ are arranged so as to form not only longitudinal series, but also a very regular spiral line around the axis (Pl. XVII. fig. 15). This character is not the exclusive pecu-

Fig. 1.



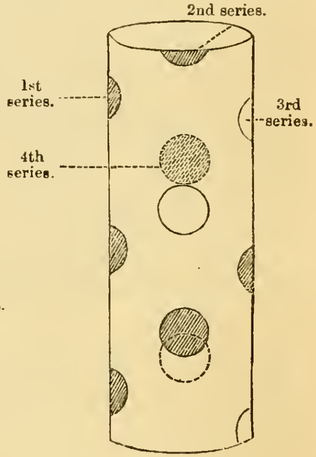
Biserial type.

Fig. 2.



Type multiserial by displacement.

Fig. 3.



Type multiserial by torsion.

liarity of *Selaginopsis decemserialis*, but, as we have already seen, it belongs also to the other species that I have described; throughout we have found that no two orifices of the more or less numerous series ever come at the same level. This spiral arrangement, which, as I believe, is common to the whole genus, renders it possible to attempt an explanation of the polyserial type, not by means of the displacement of the hydrothecæ of each series in the biserial type (that is to say, by the division of each series into two, three &c.), but simply by the torsion of the axial tube, which would produce a spiral and, at the same time, polyserial arrangement of the hydrothecæ. The figures 1–3 (p. 443) will explain what I have just said. Fig. 1 represents a biserial type; fig. 2 is a polyserial type, produced by the alternate displacement of the hydrothecæ of the same series, one to the left, the other to the right. The round spaces, of which the surface is shaded, represent the hydrothecæ belonging to the same series. It is thus that the first series in fig. 1 has divided into the first and second series in fig. 2. Lastly, fig. 3 represents the same polyserial type, but arising in this case from the torsion of the series and their position in a spiral. In fact all the species (as for example, *S. mirabilis*, *S. Hincksii*, *S. ochotensis*, and *S. decemserialis*) which have many series, and even those which have only a few (as for example, *S. pinnata*, *S. pacifica*, and even *S. triserialis*), show a very marked spiral arrangement, just as represented in the diagrammatic figure 3. If my explanation of the origin of the polyserial type by torsion were not correct, if it were necessary to accept the other explanation, we should also have to expect that, on the contrary, the arrangement represented in fig. 2 would predominate in the different species —which, however, is not the case; the spiral arrangement, as also the fact that all the apertures of the hydrothecæ in this genus are placed at different heights, cannot be explained without accepting the explanation that I have given above.

Length of the largest colony of *Selaginopsis decemserialis* 180 millims., breadth (maximum) 25; breadth of a branch 1·25; length of the hydrotheca 0·45, its breadth 0·25.

The museum of the Academy of St. Petersburg possesses several examples of this species, which differs from all the others by the decemserial arrangement of its hydrothecæ, as well as by its habit and mode of ramification.

I now proceed to mention all the other species of this genus at present known, which, together with those just described, constitute a considerable number.

7. *Selaginopsis Hincksii*, mihi.

Polyserias glacialis, Mereschk. Ann. & Mag. Nat. Hist. ser. 4, vol. xx. (1877), p. 228.

Polyserias Hincksii, Mereschk. Ann. & Mag. Nat. Hist. ser. 5, vol. i. (1878), p. 337, pl. xv. figs. 1–4.

Colony plumiform, very large and broad; branches simple, springing alternately from all sides of the stem; hydrothecæ entirely immersed in the substance of the axial tube, arranged in six regular series; aperture round or oval. Gonangia pyriform. Length 200 millims., breadth 100.

Locality. White Sea and Glacial Ocean (*C. Mereschkowsky*).

8. *Selaginopsis mirabilis*, Verrill.

Polyserias mirabilis, Mereschk. Ann. & Mag. Nat. Hist. ser. 5, vol. i. (1878), p. 335, pl. xv. figs. 5, 6.
Selaginopsis mirabilis, Norm. Ann. & Mag. Nat. Hist. ser. 5, vol. i. (1878), p. 192.

Colony plumiform; branches simple; hydrothecæ half projecting from the stem, arranged in six series; aperture with two teeth.

9. *Selaginopsis cylindrica*, J. F. Clarke.

Thujaria cylindrica, J. F. Clarke, Scient. Results of the Expl. of Alaska, vol. i. (1876), p. 22, pl. x. fig. 57.

Colony plumiform; branches disposed alternately, subdividing; hydrothecæ arranged in from four to six series, entirely immersed in the substance of the stem.

Locality. Alaska, Bering Sea, Chichi Islands.

10. *Selaginopsis bidentata*, Allm.

Pericladium bidentatum, Allm. Journ. Linn. Soc. vol. xii. (1876), p. 273, pl. xx. figs. 1–4.

Colony in the form of *Thujaria thuja*; branches subdividing into four, and each divided into two internodes, of which only the inner one (the first) bears oval gonangia; hydrothecæ in eight to ten (?) series, not entirely immersed; aperture with two teeth.

Locality. Japan.

11. *Selaginopsis Allmani*, Norm.

Selaginopsis fusca, Allm. *l. c.* p. 272, pl. xii. fig. 1, and pl. xix. figs. 1, 2.
Selaginopsis Allmani, Norm. Ann. & Mag. Nat. Hist. ser. 5, vol. i. (1878), p. 192.

Branches arranged on two sides of the stem, subdividing; hydrothecæ not entirely immersed, cylindrical, with the margin slightly waved, arranged in four rows (in pairs); colour very dark.

Locality. Japan.

12. *Selaginopsis fusca*, Johnston.

Sertularia fusca, Johnst.
Selaginopsis fusca, Norm. *l. c.* p. 191.

Colony plumiform; hydrothecæ arranged in four series, in twos on each side of the very compressed branch.

Locality. England.

I here give a dichotomic Table which will facilitate the determination of all the species of the genus *Selaginopsis*:—

1. Branches springing from two sides only of the stem (colony pinnate)	2.
Branches springing from all sides of the stem (colony of the form of *Thujaria thuja*, except *S. triserialis*).	8.
2. Branches subdividing into branchlets	3.
Branches simple, not subdividing	4.
3. Hydrothecæ arranged in four series; branches not wide	*S. pacifica.*
Hydrothecæ in from four to six series; branches broader, cylindrical	*S. cylindrica.*
4. Hydrothecæ arranged in six series	5.
Hydrothecæ in four series	6.
5. Hydrothecæ entirely immersed in the substance of the branch; margins of the aperture smooth	*S. Hincksii.*
Upper part of hydrothecæ projecting; aperture with two teeth	*S. mirabilis.*
6. The four series arranged in pairs	7.
The four series not arranged in pairs	*S. pinnata.*
7. The two series of one pair distinct; hydrothecæ cylindrical, long	*S. Allmani.*
The two series of one pair not distinct; hydrothecæ not cylindrical, more or less quadrate	*S. fusca.*
8. Hydrothecæ arranged in three series	*S. triserialis.*
Hydrothecæ forming more than three series; colonies of the form of *Thujaria thuja*	9.
9. Hydrothecæ entirely immersed in the substance of the branch; orifice with a smooth margin	10.
Hydrothecæ projecting at their upper part; orifice with two teeth	11.
10. Three branches forming a system; series of hydrothecæ ten (at least)	*S. decemserialis.*
Six branches forming a system; series of hydrothecæ six or seven	*S. thuja.*
11. Four branches forming a system; series eight or nine?	*S. bidentata.*
Six branches forming a system; series eight or nine	*S. ochotensis.*

I now pass to the description of a new species of *Sertularia*, and of a very interesting *Sertularella*, both from the North Pacific Ocean.

Sertularia compressa, sp. n. (Pl. XVII. figs. 17–19.)

Trophosome. Hydrorhiza in the form of stolons. Hydrocaulus short, erect, not angular, rather rigid, divided into irregular internodes, only giving off very few ramifications. Branches arranged alternately and regularly on two sides of the principal stem, straight, also divided into irregular internodes. Hydrothecæ arranged alternately, subopposite, one to three pairs in each internode, the base inflated and rounded, *the upper half strongly compressed* in a plane vertical to the plane of ramificatien of the colony. Aperture oval, compressed, long but narrow, with two angles on the two sides, and two very slightly developed teeth.

Gonosome. Unknown.

Locality. Port Ajan (*M. Wosnessensky*, 1848).

Two little colonies of this hydroid were attached by the hydrorhiza to the base of a colony of *Selaginopsis pinnata*. The hydrocaulus is straight and gives origin on two sides to branches alternately arranged and forming an acute angle with the stem (Pl. XVII. fig. 17). The length of these branches gradually diminishes towards the apex. The internodes of the principal stem, as also of the branches, are very irregular; sometimes they are formed of a single pair of hydrothecæ, sometimes of two or even three pairs. The hydrothecæ (Pl. XVII. figs. 18, 19) are greatly inflated in the lower half, whilst the other half becomes suddenly very strongly compressed, forming a neck. In the plane of ramification (Pl. XVII. fig. 18) the colony has a very peculiar aspect, in consequence of the inflated portion appearing to be furnished with a very long and slender neck. This neck usually makes a more or less acute angle with the principal stem and the inferior half of the hydrotheca; and this angle sometimes becomes nearly a right angle (fig. 18, ×). On turning the branch so that it may be seen from the side, the hydrothecæ assume a nearly cylindrical form (fig. 18 *a*) slightly widened at the base, with the two teeth of the two sides more or less developed. Sometimes the teeth are very slightly developed, so that one would call them rather two angles than two teeth. The aperture is compressed, as shown in figs. 19 and 19 *a*. For the better understanding of the form of the hydrothecæ I have represented one of them under a higher magnifying-power and turned a little to one side (Pl. XVII. fig. 19).

Length of the colony 12 millims.; length of the hydrothecæ 0·4, maximum breadth 0·2; width of the aperture 0·05; breadth of the whole branch, including the hydrothecæ, 0·7.

This very curious form differs from all known species of *Sertularia* by the compressed form of its hydrothecæ. It is represented in the collection of the Academy by two small colonies attached to *Selaginopsis pinnata*, and probably very young considering their small size and the absence of gonosomes.

Sertularella Clarkii, sp. n. (Pl. XVII. figs. 20–22.)

Trophosome. Hydrorhiza forming a compact layer of hydrophytons. Hydrocaulus straight, long, cylindrical, not angularly bent, with regular internodes, destitute of branches to the apex, where the width of the axial tube suddenly diminishes considerably, and it at the same time gives origin to branches. Branches divided into internodes, rather short, issuing from all sides of the principal stem, one from each of its internodes, ramified in their turn so that each branch-internode gives off a secondary branch, which is divided once or twice; and all these secondary branches are turned towards the axis of the colony (inwards). Hydrothecæ tubular, a little contracted at the extremity; aperture broad oval, *furnished with two large teeth* arranged unsymmetrically; arrangement of the hydrothecæ, although biserial, not in the same plane, having at the first glance *the appearance of being uniserial.*

Gonosome unknown.

Locality. Unalaschka (*M. Petelin*, 1847).

The hydrorhiza is formed by the agglomeration of hydrophytons so interlaced and bound together as to form a continuous layer of a dark brown colour, which gives origin to more than thirty colonies placed very close to each other. The hydrocauli, of a rather dark brown, are straight, not angularly bent, slightly and irregularly waved, cylindrical, and nearly of the same thickness throughout their length, except the extremity, which decreases very abruptly in diameter. The whole has very much the character of a colony of *Tubularia indivisa* (Pl. XVII. fig. 20). The whole stem is divided into regular internodes from 2 to 5 millims. long; and in all the brown part of the stem it is entirely destitute of branches. Only the upper part, the extremity, which abruptly becomes more slender, more delicate, and, at the same time, entirely colourless, begins to give origin to branches, which are also excessively delicate and entirely colourless. A long brown and rigid stem, having at its extremity a thick tuft of small, very delicate, and flexible branches, presents a very singular and unusual appearance. It sometimes happens that the principal stem bears one or a few small colourless branches about the middle or in the upper third; but this case is rare and exceptional.

The upper part of the stem is divided, like all the rest, into internodes; but these are shorter, and each of them gives origin to a single branch. The arrangement of the branches is spiral; that is to say, they spring from all sides. The branches, which are divided, like the principal stem, into regular internodes, are also divided into secondary branches, each internode giving origin to a single secondary branch, which is always turned towards the interior of the colony, so that the side of the primary branch turned towards the exterior of the colony is always destitute of branches (Pl. XVII. fig. 22 *). There are usually eight or ten secondary branches (fig. 22, *c*), which are either simple or divided, usually once, rarely twice. At the same time the secondary branches are not placed in the same plane. All this division and subdivision, which is very complicated in our species, is the more difficult to see, because the branches, owing to their flexibility, curve and interlace to form a dense tuft. The hydrothecæ (Pl. XVII. fig. 21) are cylindrical, a little compressed at the extremity, a little inflated at the base, furnished with a wide aperture with its margin armed with two long teeth, which are not placed exactly opposite to each other. Their position is exactly analogous to that of the hydrothecæ in *Sertularella pinnata*, S. F. Clarke; that is to say, although biserial, they are not placed in one and the same plane, but "inclining towards each other, so that in a general view they appear to be arranged uniserially (Pl. XVII. fig. 21). The hydrothecæ on the secondary branches are arranged alternately."

Length of the largest colony 80 millims.; length of the colourless part divided into branches about 15; length of hydrothecæ 0·37, maximum breadth 0·16.

This curious species of *Sertularella* differs strikingly from all other known species by the general form of the colony, the mode of ramification, the bidentate hydrothecæ, and especially by the singular manner in which these are arranged upon the branches, affecting a uniserial arrangement. By this last character this species very distinctly approaches *Sertularella pinnata*, Clarke, the finest species that I know. *Sertularella Clarkii*, however, is distinguished from this by the absence of the plumose character of the colony (which renders *S. pinnata* so pretty), as well as by the presence of only two instead of three teeth. The arrangement of the hydrothecæ in both species has some analogy with that occurring in *Hydrallmania falcata* and in the genus *Desmoscyphus* †.

There are in the collection of the Academy more than twenty magnificent specimens of this hydroid united upon a common layer of hydrorhiza, brought from Unalaschka.

I give this species its specific name in honour of the American zoologist S. F. Clarke, author of several excellent works on the Hydroids of America.

* This figure only represents the mode of ramification, in the species in question, diagrammatically.

† Allman, Journ. Linn. Soc. vol. xii. (1876), p. 264, pl. xiv. figs. 3–7.

Sertularella pinnata, S. F. Clarke. (Pl. XVII. fig. 23.)

Sertularella pinnata, S. F. Clarke, Scient. Results Explor. Alaska, 1876, vol. i. p. 22, pl. vi. figs. 28, 29.

I think I may say that this is one of the prettiest hydroids hitherto described. It was described in 1876 by Mr. S. F. Clarke; and his description is so perfect that I can only add very little to complete it. The collection of the Academy possesses a very considerable quantity of this species, among others also coming from Unalaschka, where it appears to be very abundant. The hydrothecæ are often bent in the middle, forming a fold, although this fold is also frequently wanting. Sometimes, although rarely, the arrangement of the hydrothecæ becomes normal, so to speak; *i. e.* it does not affect a uniserial mode. As Mr. Clarke has not given a figure of the whole colony, the general appearance of which is very characteristic and pretty, I think it desirable to give one (Pl. XVII. fig. 23) representing a colony with gonophores.

EXPLANATION OF THE PLATES.

Plate XVI.

Fig. 1. *Selaginopsis triserialis*, sp. n.: a colony, of the natural size.
Fig. 2. A portion of a branch of the same species, enlarged 25 diameters, and drawn with the camera lucida.
Fig. 3. *Selaginopsis pinnata*, sp. n.: a colony, of the natural size; *per*, a part of the hydrorhiza in the form of a membrane.
Fig. 4. A portion of a branch of the same species, enlarged 25 diameters; drawn with the camera lucida.
Fig. 5. *Selaginopsis pacifica*, sp. n.: a colony, of the natural size.
Fig. 6. A portion of a branch of the same species, enlarged 25 diameters; drawn with the camera lucida.
Fig. 7. A gonotheca of the same species.
Fig. 8. *Selaginopsis thuja*, sp. n.: a colony, of the natural size.
Fig. 9. A system of branches of the same species, consisting of six branches.
Fig. 10. Hydrotheca of the same species, enlarged 50 diam.; drawn with the camera lucida.
Fig. 11. *Selaginopsis ochotensis*, sp. n.: a colony, of the natural size.
Fig. 12. A system of six branches of the same species, of the natural size.
Fig. 12 *a*. A gonotheca belonging to the same species.

Plate XVII.

Fig. 13. *Selaginopsis decemserialis*, sp. n., var. *gracilis*: a colony, of the natural size, representing a variety of the species distinguished by its cylindrical form and shorter branches.
Fig. 14. A system of three branches belonging to the typical form of this species, natural size.
Fig. 15. A portion of a branch of the same species, enlarged 25 diameters, drawn with the camera lucida.
Fig. 16. A gonotheca belonging to the same species.

Fig. 17. *Sertularia compressa*, sp. n.: two small colonies upon a stem of *Selaginopsis pinnata*, natural size.
Fig. 18. A branch of the same species, enlarged 25 diameters, drawn with the camera lucida: ×, the neck bent nearly at a right angle to the axis of the branch.
Fig. 18 *a*. A hydrotheca of the same species, seen from the flat side (in a plane vertical to the plane of ramification).
Fig. 19. A hydrotheca seen from the side, enlarged 75 diameters; drawn with the camera lucida.
Fig. 19 *a*. The aperture and a part of the side of the hydrotheca of the same species, enlarged 50 diameters.
Fig. 20. *Sertularella Clarkii*, sp. n.: a colony, of the natural size.
Fig. 21. A portion of the colony of the same species, enlarged 50 diameters; drawn with the camera lucida.
Fig. 22. A portion of the colony of the same species, represented diagrammatically, to show the mode of ramification: *a*, the principal stem; *b*, a primary branch; *c*, secondary branches, bearing branches of a third category.
Fig. 23. *Sertularella pinnata*, S. F. Clarke: a colony, of the natural size.

XLIX.—*Descriptions of two new Species of Spiders.* By T. Workman, Esq.

[Plate XVIII. figs. 1 & 2.]

Pholcus Margarita, n. sp.

♀ adult, length 9 millims.; ♂ rather shorter.

Cephalothorax. Length 1 millim.; round, rather squared; colour yellow, with two black lines in front from the eyes to the falces, also a dark brown band with black margins from the eyes to the abdomen, broadest behind, sparingly covered with hairs.

Eyes eight, seated on dark spots; the two anterior are the smallest; those of the lateral groups are about equal in size, which groups are placed about the breadth of one of the eyes apart.

Legs very long and slender, provided with short fine hairs; relative length of legs of male 1, 2, 4, 3; total length of anterior legs 63 millims. Colour yellow, with white markings at the end of the femur and tibia, the end of the genual joint dark brown; superior claws of tarsus deeply pectinated.

Palpi short, strong; colour yellow. Palpal organs of male well developed, but simple in structure, having a sort of conical tube projecting downwards with black points, as seen from outer side; female palpi terminated with two simple claws.

Falces short, vertical; colour brown; armed on inner edge with a short strong spine.

Maxillæ pointed, meeting in front of the lip, projecting forwards toward the falces.

Labium semicircular; colour brown, with a dark line down the centre.

Sternum heart-shaped, with indentations opposite the legs; colour brown.

Abdomen oval in front, pointed behind, projects a little over the cephalothorax; colour yellow, with dark brown markings somewhat similar to *P. phalangioides* (Fuessl.); genital aperture (female) of a dark brown colour, with a light-brown tongue-shaped organ with a round knob at the point, projecting forwards; the branchial opercula are placed in front of it, and are triangular in shape and dark in colour.

Hab. Rangoon, Burmah.

This species was found living in considerable numbers along with *Theridion luteipes*, Cambr., and another small *Theridion*, on board a ship in Liverpool, with rice from Rangoon. The female carries its egg-cocoon in its falces.

Theridion Thalia, n. sp.

♀ adult, length 2 millims.; ♂ rather longer.

Cephalothorax nearly 1 millim. in length, oval forward and more pointed; the head marked by an indentation, and but slightly raised above the cephalothorax. Colour dull yellow, with dark lines radiating towards the insertion of the legs, with a few rather long hairs.

Eyes eight, placed in two rows, the central four forming a trapezoid with the broadest side behind; the posterior two, which are the largest, placed about their own breadth apart; the lateral eyes are contiguous on dark spots.

Legs. Colour yellow, sparingly covered with long hair; relative length of legs 1, 4, 3, 2.

Palpi twice the length of falces, same colour as legs; palpal organs of male simple, with a curved spinal process on lower side and a twisted point tipped with black; a single strong bristle on upper side of cubital joint.

Falces slightly pointed forward.

Maxillæ pointed, nearly meeting in front of the labium, projecting towards the falces.

Labium semicircular.

Sternum heart-shaped, with indentations opposite the legs; colour dark yellow.

Abdomen globular in female; colour yellowish white, with dark markings along the side extending to the spinners; genital aperture with a curved lip and two brown markings above it. Abdomen in male long and flattish, dark in colour, with a transverse whitish band across the middle of the back and a few white spots; lower side yellow, with a few fine teeth where it projects over the cephalothorax.

Hab. Rangoon, Burmah.

This species was found living in considerable numbers, along with *T. luteipes* (Cambr.) and a *Pholcus*, on board a ship in Liverpool, with rice from Rangoon. The female carrying its egg-cocoon attached by short silken lines to the spinners, as does a small British spider of the same genus (*Theridion bimaculatum*, Linn.).

EXPLANATION OF PLATE XVIII. figs. 1 & 2.

Fig. 1. *Pholcus Margarita*: *a*, ♂, underside; *b*, ♀, slightly enlarged; *c*, front view of eyes and falces; *d*, ♂ palpus; *e*, ♀ epigynæ.

Fig. 2. *Theridion Thalia*: *a*, ♂, underside; *b*, ♀; *c*, ♂ palpus; *d*, epigynæ, ♀; *c*, ♂, side view; *f*, ♀, ditto.

L.—*Note on* Diastylis bimarginatus *from the Coast of Aberdeenshire.* By George Sim.

[Plate XVIII. figs. 3–5.]

In reference to the above, as described and figured by Mr. Spence Bate in the Ann. & Mag. Nat. Hist. for May last, and which crustaceans were sent to him by me, I have to say that both the description and figure of the *Diastylis* are so defective and unlike the animal, that, were others of the same species found and referred to the description and figure as given by Mr. Spence Bate, the conclusion could not fail to be arrived at that there was no relationship whatever between the specimens found and those referred to by Mr. Bate. All this I have already pointed out to Mr. Bate.

The annexed figures are the result of numerous careful microscopical examinations of the animal while in a fresh and perfect condition, excepting, of course, the legs, which were broken when the creature was found.

The name Mr. Bate has given, viz. *Diastylis bimarginatus*, is happily chosen, being descriptive of the animal, and on that account is cheerfully retained.

In giving my description it will, I think, be better to put those portions which differ from Mr. Bate's in italics, so that the difference may be the more easily observed.

Diastylis bimarginatus.

The carapace long and *cylindrical*; the infero-lateral margin is *anteriorly produced to a broad obtuse point, and, when viewed dorsally, is seen to turn outwards, and is fringed with stiff hairs, which fringe extends along the antennal notch, around the rostral projection, and along the lateral margin for the first third of its length.* A second ridge commences at the dorsal aspect, *and considerably behind the base of the rostrum,* continuing along the lateral to the posterior extremity of the carapace, where it joins the infero-lateral margin. *Along the whole length of this second ridge it is cut into at regular intervals, leaving a comb-like edge of broad flat teeth. In front of and along the lower side of this ridge is a deep hollow, which makes the comb-like process stand out in bold relief. The whole of the carapace is thickly set with short hairs.* Five somites of the pereion are exposed behind the carapace, *all of nearly the same depth,* but longer as they succeed each other posteriorly, the last having its latero-posterior angles produced to long sharp points, *extending the whole length of the first somite of the pleon.* The first five somites of the pleon are dorsally crowned with stout bent spines, becoming less on each succeeding somite. *The first four somites of the pleon have their posterior angles rounded*; but the post-inferior angles of each are produced to sharp spine-like points. The fourth somite has several spines on the lateral margin. The fifth somite is longer than the four preceding, *its upper posterior margin being produced to an obtuse point; there are four short stout teeth on the dorsal* aspect, several small spines on the lateral margin; and it is armed at the posterior extremity with one strong tooth. The sixth somite is *irregularly cylindrical,* having *no spines but one on the lower surface.* The telson is long, sharp, and styliform, *and set on each side with short stout spines, increasing in size posteriorly.* The styliform uropoda have the first joint about *a sixth longer than the telson,* and supporting two branches, of which the *outer is about a third longer than the inner; and all are fringed with hairs.* The peduncles of the first pair of antennæ are fully as long again as the rostrum. In the second antennæ the first and second joints of the peduncle do not extend beyond the rostrum, and the third joint, which is broad at the posterior extremity, tapers gradually forward, and is set with short spines on its inner edge; it extends somewhat beyond the extremity of the first pair of antennæ. The filiform appendage extends nearly the whole length of the animal.

The fragments of legs figured are all that remained when the animal was found.

EXPLANATION OF PLATE XVIII. figs. 3–5.

Fig. 3. *Diastylis bimarginatus.*
Fig. 4. The same, dorsal view.
Fig. 5. Fragments of legs of same: 1, part of first leg; 2, part of second leg; and so on to 5, which is the last.

NOTE.

Since the above was placed in the hands of the printer, I have seen, in the 'Annals' for Nov., a reference made by the Rev. A. M. Norman to the species above referred to, in which he says that *Diastylis bimarginatus* is identical with *D. spinosa*, a species described by him in the British-Association Report for 1868. This he considers must be the case from the similarity of the description given by him and that of my species as given by Mr. Bate in the May number of the 'Annals;' but then it will be seen from the foregoing that Mr. Bate's remarks do not describe the species I sent him.

LI.—*Descriptions of some new Genera and Species of Lepidoptera from Old Calabar and Madagascar.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

IN the collections from which the novelties here recorded were selected were the following interesting described species:—

MADAGASCAR.

Nephele Densoi, *Kef.*
Chœrocampa geryon, *Boisd.*
Eusemia zea, *H.-Sch.*
(N. gen.) crocipes, *Boisd.*
Bunæa aslauga, *Kirb.*
—— eblis, *Streck.*
Phragmatœcia arundinis (European species).
Cyligramma fluctuosa, *Guén.*
Cyligramma duplex, *Guén.*
—— conturbans, *Walk.*
—— joa, *Boisd.*

OLD CALABAR.

Phægorista similis, *Walk.*
Brahmæa Swanzii, *Butl.*
Ophideres cocalus, *Cram.* (Indian species).

C. conturbans is described from an example said to have been taken in Hindostan.

Nephele bipartita, n. sp.

Primaries divided into two equal areas by an oblique black belt from the centre of the costa to the external angle; the basal area sordid testaceous, clouded with fuliginous, reddish at base of costal border; three zigzag, parallel, abbreviated, black lines across the cell, the area enclosed by the two outer lines dusky; three slightly irregular, indistinct, blackish lines across the inferior portion of the disk near the external angle; a minute white dot at the end of the cell; apical area dark chocolate-brown, blotched with subcostal and submarginal squamose testaceous patches: secondaries olivaceous, becoming reddish beyond the middle, and with a broad, tapering, blackish border; costal area greyish; fringe pale reddish brown, white towards the anal angle: body sordid clay-coloured, clouded with olivaceous, the abdomen crossed by black belts, which widen abruptly at the sides. Under surface rusty reddish brown, palpi whitish; wings with broad, dusky outer border, and three parallel discal sinuous lines, the central line least distinct; primaries with dusky basal area and whitish inner border; secondaries rather paler than the primaries; venter with lateral black stigmata. Expanse of wings 3 inches 6 lines.

Old Calabar.

Caryatis syntomina, n. sp.

Primaries fuliginous brown, with the veins on the basal area whitish; a vermilion basal spot, on which are three small black spots; an oblique, subapical, white belt separated by the nervures into six parts: secondaries white, sordid below the median vein; the veins beyond the middle, a discocellular spot, the apex and outer margin dark fuliginous brown: head, collar, and thorax red, spotted with black; abdomen and under surface of body ochreous; legs below, excepting the tarsi, with white borders: wings as above. Expanse of wings 1 inch 11 lines.

Old Calabar.

The genus *Caryatis* has usually been referred to the Hypsinæ; it is, however, nearly allied to *Pelochyta*. *Zaracha extranea*, Wlk., is probably a third species of *Caryatis*.

Areas virginalis, n. sp.

Pearly white; primaries speckled with brown, and with a brown crescent at the end of the cell; secondaries speckled with brown beyond the cell, and with a brown spot at the end of the cell; head orange, with the frons and antennæ black; abdomen orange, with a dorsal series of six transverse black spots, followed by a broad black belt near the anus: body below white; the femora above, the palpi, and collar orange; the knees and upperside of the tibiæ and tarsi black; venter with a lateral series of black dots. Expanse of wings, ♂ 2 inches, ♀ 2 inches 7 lines.

Betsileo country, Madagascar.

DAPHŒNURA, n. gen.

Allied to *Eucharia* (*E. Hebe*, Linn); but the primaries with more elongated costal margin, more convex outer margin, shorter inner margin, the secondaries comparatively smaller, with the discocellular veinlets more transverse, and the radial emitted from the discocellulars at some distance from the third median branch; antennæ with very short pectinations, even in the male, the head rather more prominent, the thorax narrower, the abdomen of the male with a well-defined terminal bushy tuft of hairs. Type *D. fasciata*.

Daphœnura fasciata, n. sp.

Primaries above rich golden orange, the base, a broad subbasal transverse belt, two transverse stripes before the middle, an irregular spot at the end of the cell, a sinuous discal stripe, and the outer border black: secondaries bright ochreous, with the abdominal and external borders black: head, thorax, and anus carmine; abdomen black; antennæ black. Wings below bright ochreous, with black outer border, base black: primaries with two spots near the middle of the costal border, a crescent at the end of the cell, and an angular discal belt black: body below black, with the anus carmine. Expanse of wings, ♂ 2 inches 3 lines, ♀ 2 inches 2 lines.

Ellongo, Madagascar.

This splendid moth seems to be not uncommon at Ellongo; the collection contained five or six examples.

Sozuza argentea, n. sp.

Silvery white, primaries with three black spots arranged in the form of a triangle, the first subcostal, the second on the second median interspace, the third (at basal third) upon the interno-median area; front of head, lower part of palpi, upper surface of anterior legs, knees and upper surface of tarsi of the remaining legs black; antennæ and upper surface of abdomen greyish; anus below tinted with ochreous. Expanse of wings 1 inch 7 lines.

Ellongo, Madagascar.

I find that I was wrong in rejecting Wallengren's genus *Sozuza*; the neuration of the primaries at once characterizes it. The following described species are referable to this genus:—*Lithosia marginata*, Guén., from Madagascar; *L. Kingdoni*, Butl., from Madagascar; and *L. pygmæa*, Walk., from South Africa. *L. cephalica*, from America, differs entirely in the neuration of the primaries, although very similar in general form and appearance.

Chærotriche mirifica, n. sp.

Primaries bright sulphur-yellow, covered with large dark-orange spots, which upon the disk form an irregular oblique series in which all the spots are of a quadrate form; veins and margins also orange; two plumbaginous belts formed of oval connected spots, one near the base, the other just beyond the middle: secondaries bright ochreous, with the costal area and apex broadly bright sulphur-yellow spotted with orange; an ill-defined orange belt from the abdominal margin to the fourth median, where it (indistinctly) joins a large subapical orange spot; apical margin orange: thorax and base of abdomen deep reddish orange, almost red; remainder of abdomen ochreous. Under surface altogether of a more golden or saffron-yellow tint, the orange spots less red, the plumbaginous belts obsolete. Expanse of wings 3 inches.

Old Calabar.

This is by far the most beautiful species in the genus, if not in the family. The genus *Chærotriche* contains the following species known to me:—*C. crocea*, Wlk.; *C. plana*, Wlk.; *C. atomaria*, Wlk.; *C. plagiata*, Wlk.; *C. Edwardsii*, Newm.; *C. dersa*, Moore; *C. comparata*, Wlk.; *C. discinota*, Moore. Also, probably, *C. vitellina*, Koll.; *C. varia*, Wlk.; *C. distincta*, Feld.; *C. conspersa*, Feld.; *C. globifera*, Feld.

HELICOMITRA, n. gen.

Allied to *Pterothysanus*; wings with similar neuration, but broader, with different style of marking; the basal half of the wings covered more or less densely with upright hairs, some of which are curiously thickened above the middle (like bulrushes); a radiating tuft of fine hairs at the base of the abdominal margin; abdominal fringe rather long, but not extending quite to the anal angle: body much more robust than in *Pterothysanus*. Type *H. pulchra*.

Helicomitra pulchra, n. sp.

Snowy white; wings crossed by four series of annular black markings, the third and fourth being near together on the externo-discal area, the spots of the third series more or less lunate; a marginal series of partially black-edged ochreous spots: primaries with the base black-spotted; a black annulus in the cell; two large black costal patches; the basal half of costal margin vermilion-red; three partially black-edged vermilion costal spots between the cell and apex; apical area greyish: head black in front, with a white margin, white behind with a central black spot; collar tinted behind with ochreous, black-spotted at the sides; an orange humeral spot on each side; base of tegulæ black; thorax with a large black dorsal spot divided by a central white line, two black spots behind; abdomen with two dorsal series of transverse black spots, sides orange with white edges to the segments. Under surface white, markings obsolete excepting at the borders of the wings; primaries with a large apical black patch; venter yellowish, with ill-defined transverse dusky belts and a series of black spots on each side; legs above brown, the tarsi black with white belts; anterior coxæ orange, femora of second pair of legs vermilion below. Expanse of wings 3 inches 3 lines.

Betsileo country, Madagascar.

In marking this singular species reminds one of the genus *Ecpantheria*.

Gogane ochrea, n. sp.

Primaries above bright ochreous, the fringe sericeous; secondaries rather paler than the primaries, sericeous all over: body ochreous, the thorax paler than the head, collar, and abdomen; anal tuft greyish brown: under surface ochreous, sericeous, uniform in tint. Expanse of wings 2 inches.

Madagascar.

This species, from the similarity of its general coloration, reminds one of the "*Aganais insularis*" of Boisduval.

The genus *Gogane* is nearly allied to *Chærotriche*, and contains, besides the above, *G. atrosquama* of Walker and *G. glandulosa* of Felder.

Anaphe venata, n. sp.

Wings cream-coloured: primaries with the veins, margins, and a central belt bright chocolate-coloured; secondaries with the apical fringe slightly brownish, bright chocolate dots at the ends of the veins: head, inner fringe of tegulæ, and thorax red-brown, collar and outer border of tegulæ cream-coloured; abdomen pale red-brown, the segments whitish in front; antennæ black: under surface with the markings less distinct than above. Expanse of wings 2 inches 3 lines.

Old Calabar.

Readily distinguished from the described species by the single red-brown belt and the red-brown veins of the primaries. In *A. reticulata*, *A. panda*, and *A. ambrizia* there are two belts and two longitudinal streaks (limiting the median interspaces), and the brown borders are much wider than in *A. venata*.

Dasychira ampliata, n. sp.

♀. White: primaries finely speckled with smoky brown, and crossed by two irregular lunulated belts, the inner one edged with more numerous brown scales, the outer one blackish internally and with a squamose greyish external border; an ill-defined submarginal greyish squamose belt followed by a slightly undulated black line; a slender grey marginal line: secondaries suffused with pale smoky brown, excepting upon the costal area: abdomen greyish; antennæ with reddish-brown pectinations. Under surface white, the wings, particularly the primaries, clouded with very pale greyish brown, the veins brownish. Expanse of wings 3 inches 7 lines.

Ellongo, Madagascar.

This species, in every thing but its antennæ and neuration, bears a remarkable resemblance to *Lobeza aglone*, H.-Sch., from Rio Janeiro; the likeness is as great as in any recorded case of protective assimilation.

The egg of *D. ampliata* is very large, subglobose, smooth, the upper half being coloured with alternate concentric circles of olivaceous and whitish, the lower half snow-white.

Spidia, n. gen.

Allied to *Drepana*, neuration similar: primaries much broader, the outer margin deeply excavated below the apex and regularly convex from the sinus to the external angle, considerably less oblique; inner margin much longer: secondaries with the outer margin almost straight, so that the anal angle is much more acute. Type *S. fenestrata*.

Spidia fenestrata, n. sp.

Coloration and aspect of *Drepana scabiosa*, excepting in size and form. Brownish grey, with a pearly lustre; wings divided into two areas by an oblique blackish stripe from the apex of the primaries to the basal third of the abdominal margin of secondaries, the area beyond the stripe darker than the basicostal area: primaries with a hyaline white spot at the end of the cell, and four smaller hyaline spots half encircling it externally: secondaries with an abbreviated blackish stripe across the apical third of the abdominal area: body blackish. Under surface pale silvery greyish brown, speckled with black; hyaline spots as above. Expanse of wings 1 inch 9 lines.

Old Calabar.

Copaxa discrepans, n. sp.

♂. Bright chrome-yellow, wings with a black spot enclosing a hyaline white centre at the termination of each discoidal cell; fringe red-brown: primaries sprinkled here and there, particularly at the base, with rusty scales; a very irregular red-brown stripe across the basal third; a second, less irregular central stripe, a third almost straight oblique discal stripe from apex to inner margin; a submarginal series of more or less concave red-brown spots: secondaries crossed in the middle by a rather broad, straight, red-brown stripe, and on the disk by a zigzag line; a submarginal series of more or less hastate red-brown spots: body sprinkled with rusty scales. Under surface darker; the stripes, lines, and spots purplish; the ocelloid spots smaller; the whole surface of the wings sprinkled more or less densely with rust-brown scales, most thickly upon the outer border and between the stripes of primaries, the stripe nearest to the base being obsolete. Expanse of wings 5 inches 11 lines.

♀. Olive-brown, sprinkled with yellow scales, most densely between the outer or discal stripe and the submarginal row of spots; ocelli larger than in the male; otherwise the characters are the same. Expanse of wings 5 inches 6 lines.

Old Calabar.

CERANCHIA, n. gen.

Nearly allied to *Saturnia*, but the antennæ broadly and equally pectinated in both sexes, the wings hyaline, the radial vein of primaries emitted in the male (but not in the female) from the fourth subcostal branch, with which it forms a fork starting from an apparently independent footstalk at the superior angle of the discoidal cell. Type *C. apollina*.

Ceranchia apollina, n. sp.

White; wings hyaline, with pale smoky-brown borders and dusky veins; an arched postmedian grey stripe; a black-zoned orange spot at the end of each discoidal cell, those of the primaries in the male very pale; primaries of the female with an ill-defined dusky stripe across the cell to inner margin; antennæ black; head, prothorax, and legs tawny. Expanse of wings 4 inches 6–9 lines.

Betsileo country, Madagascar.

It was only after examining four or five examples of this species that I was finally persuaded that the structural difference in the veins of the primaries was a male character, whilst the antennæ of the sexes did not differ: the cocoon is reticulate and silvery.

Gonimbrasia, n. gen.

Allied to *Imbrasia*, but the antennæ of the males pectinated to the apex, the outer margin of the primaries usually straighter, the outer margin of the secondaries obtusely subangulated, not caudate. Type *G. nictitans*.

To this genus may also be referred *Imbrasia rhodophila* and *I. alopia*.

Gonimbrasia obscura, n. sp.

Primaries dull reddish brown, ferruginous towards the base, clouded with fuliginous at and beyond the end of the cell, speckled with grey upon the external area; a dusky interrupted zigzag transverse streak, broadly bordered externally by a diffused pink belt, limiting the basal area, a nearly semicircular hyaline white spot at the end of the cell; an oblique diffused dusky stripe, from costa to inner margin, immediately beyond the hyaline spot; a dark brown oblique discal stripe, parallel to the outer margin, bordered on both sides by pink stripes, the outer one irregularly sinuated, both diffused and expanded at the costa, so as to form a broad costal patch: secondaries olive-brown, becoming fuliginous towards the centre of the wing; abdominal border reddish; base rosy; two divergent white stripes from the abdominal border to the subcostal vein, the outer one obtusely subangulated and bounded externally by a narrow blackish stripe; a large central ocellus touching the outer stripe gravel-yellow, with semicircular hyaline white centre, black iris, dull lake-red margin, and pink border; disk from the abdominal margin to the radial (or third subcostal) branch traversed by a pinky-white zigzag squamose stripe: body clay-coloured, becoming ferruginous towards the head, posterior border of thorax pink. Wings below altogether paler, broadly tinted with pink, the stripe nearest to the base of primaries obsolete, the stripe at the end of the cell very broad and diffused; two dusky discal stripes, beyond which is a broad zigzag pink stripe: secondaries with an ill-defined dusky stripe beyond the black stripe; ocellus reduced to a hyaline spot with fulvous margin; zigzag discal stripe continued to the first subcostal branch: body clay-coloured, uniform in tint. Expanse of wings 5 inches.

Old Calabar.

This genus is most nearly allied to *Bunœa* both in pattern and structure, but differs in its shorter antennæ and more angular secondaries.

Attacus perspicuus, n. sp.

Size and general coloration of *A. vacuna*, the discal white belt similar in position and form, but the area beyond this belt broadly sprinkled with snow-white scales; the ocelloid hyaline patch of primaries as in *A. mythimna*, and that of the secondaries subquadrate and very large; the outer border of primaries pale olive-brown, traversed internally by a deeply and regularly crinkled black line, with longitudinal black dashes internally between the sinuations, much as in *A. atbarinus*; outer border of secondaries intermediate in colour and spotting between *A. vacuna* and *A. mythimna*; basal white belts as in *A. vacuna*, but whiter and sharply defined; pectus white. Wings below differing from *A. vacuna* as upon the upper surface. Expanse of wings 5 inches 4 lines.

Old Calabar.

STIBOLEPIS, n. gen.

Aspect of *Melanothrix**, but neuration of *Sarmalia*, excepting that the discoidal cells are half as long again. Type *S. nivea*.

Stibolepis nivea, n. sp.

♂. Snowy white; wings with black external borders traversed by a deeply dentate-sinuate white line; fringe alternately black and white: primaries with a series of black spots, interrupted on the median interspaces, close to the external border; costal border crossed by black dashes, the four nearest the base continued, as grey and ill-defined stripes, across the wing: secondaries with a subcostal black dash close to the external border: head fulvous in front, black behind; antennæ dark brown; thorax with a longitudinal central black line; tegulæ crossed by black humeral stripes; abdomen fulvous. Wings below white, the veins yellowish; a dentate-sinuate black outer border; fringe black, spotted with white: primaries with the base of costal border and the costal margin black: body ochreous, abdomen with a series of black dots on each side. Expanse of wings 2 inches 11 lines.

Old Calabar.

This genus and the other two with which I have compared it will come into the Bombycidæ, in the neighbourhood of *Jana*.

Zenzera cretacea, n. sp.

♂. Intermediate in colouring and marking between *Z.*

* *Melanothrix pulchricolor* is identical with *Gnophos? nymphaliaria* of Walker.

asylas and *Z. capensis*, but differing from both in that the primaries have a longitudinal black costal stripe beyond the cell, and a white streak followed by an oblong black spot on the interno-median area: primaries with the costal two thirds chalky white, crossed by black striations, and with a black semicircular streak at outer margin, internal area broadly greyish brown: secondaries greyish brown, with dark grey reticulations; costal area white, a dusky-bordered convex sordid-white external patch: head yellow in front, deep grey behind; antennæ black; collar black; thorax brown, with snow-white tegulæ; abdomen above white, crossed by grey belts, which become black at the sides. Under surface paler, altogether more uniform in colouring; the costal and interno-median black dashes of primaries obsolete; pectus blackish. Expanse of wings 3 inches 2 lines.

Ellongo, Madagascar.

Achæa sypnoides, n. sp.

Basal area laky brown, veins grey; a basicostal black annulus with a black dash beneath it; central area occupied by a very broad irregular white band, unequally undulated internally and limited by a black zigzag line externally; a very irregular olivaceous central marking, two black dots at the end of the cell; an angulated dentate-sinuate olivaceous line nearly parallel to the outer border of the central band, which is also broadly olivaceous; inferior half of external area sordid whitish, trasversed by brown-bordered white lunules; apical half purplish brown internally, rather narrowly and very irregularly pale brown externally; a sinuated black marginal line: secondaries pale greyish brown, with a broad, diffused, tapering, darker belt; outer border greyish, varied with white; a sinuated black marginal line: body pale sericeous brown. Under surface whity brown, with a paler, almost white postmedian belt, limited internally by a grey, and externally by a blackish stripe; disk dark smoky brown, outer border greyish with black marginal spots: secondaries with a dusky discocellular spot. Expanse of wings 2 inches 7 lines.

Old Calabar.

Nearest to *A. intercisa*, but altogether larger and different in colouring; it has some resemblance to *Sypna picta*.

Eumelea stellata, n. sp.

Stramineous, wings mottled with ferruginous, with two ill-defined oblique central lines and a marginal line dark ferruginous; three unequal clear patches or spots beyond the middle in a transverse series; apex and a patch upon the outer margin sparsely mottled with ferruginous; fringe stramineous, spotted with brown at the ends of the veins; a slightly irregular discal series of brown-edged silvery spots; a blackish discocellular spot: secondaries with a clear, transversely elliptical patch just beyond the middle of the subcostal area; apex and some spots on the outer border sparsely speckled with ferruginous; fringe and silvery discal spots as in the primaries: body pale. Under surface of wings pale ochraceous, the mottling ill-defined, excepting upon the external third of the wings; pale patches as above; silvery spots obsolete; all the wings with blackish discocellular spots: body whitish. Expanse of wings 1 inch 11 lines.

Old Calabar.

E. stellata comes nearest to *E. ludovicata* (a common Malayan form), the pattern of the under surface being somewhat similar; it, however, bears a greater resemblance, in the colour and pattern of the upper surface, to the little genus *Stegania*.

Ophthalmodes squalida, n. sp.

Wings pale greyish testaceous, clouded with pale olivaceous and densely mottled with dark brown; the usual discoidal spots outlined in brown; a marginal series of black spots; two very ill-defined, parallel, sinuated, discal brownish lines; fringe and the costa of primaries testaceous, spotted with black: body pale brown, mottled with darker brown. Wings below with the basal two thirds sordid white, mottled with grey; discoidal spots dusky; external third fuliginous brown; fringes as above: primaries with a dusky line beyond the cell; costa yellowish, spotted with grey; apex and a spot on external border white: secondaries with a white apical spot: body very pale greyish brown. Expanse of wings 2 inches 3 lines.

Old Calabar.

LII.—*Additions to the Crustacean Fauna of New Zealand.* By T. W. Kirk, Assistant, Colonial Museum, Wellington, N. Z.

Caprella lobata.

A single specimen of this species dredged in Cook Strait in January 1876.

Caprella novæ-zealandiæ, sp. nov.

Cephalon furnished with a spinous tooth directed forwards.

First segment of pereion rather short, second long, third and following gradually decreasing. Superior antennæ two fifths of the length of animal; flagellum with the infero-distal extremity of each articulus produced, but without cilia. Inferior antennæ not so long as the peduncle of the superior by one joint. Second pair of gnathopoda articulating behind the centre of the second segment of the pereion; propodos ovate; palm armed with a prominent posterior tooth, and a smaller but distinct anterior tooth (not lobe); dactylos very much curved. Three posterior pairs of pereiopoda have the anterior margins excavate, the part against which the closed dactylos impinges armed with a tooth. Length 1 inch.

Hab. Cook Strait.

This species approaches *C. geometrica*, Say, from which it differs, however, in the form of the spine on the cephalon, in the length of the antennæ, and in the articulation and arming of the second pair of gnathopoda.

Squilla indefensa, sp. nov.

Rostral plate semioval and pointed at its distal extremity. Carapace retracted in front, expanded and rounded behind, smooth, the antero-lateral angles rounded and slightly produced forwards. Large prehensile limbs with terminal joint as long as the preceding one, and armed with *nine* spines (exclusive of the terminal one, which is very large). Abdomen smooth; terminal segment with six marginal spines and three depressed longitudinal ridges, which terminate posteriorly in spines. Length $2\frac{1}{2}$ inches.

Hab. Chatham Islands and Kapiti.

Porcellana rupicola, Stimpson.

A single specimen obtained at Lyall Bay, Wellington, in May 1878.

Xantho spino-tuberculatus, Lockington.

A fine pair of this species was obtained at Porirua, near Wellington, by Mr. R. B. Gore, in January 1877.

Ebalia tumefacta, Mont.

A complete female and the right anterior leg of another specimen were obtained by dredging in Cook Strait in January 1876.

Elamena producta, sp. nov.

Carapace flat, broader than long; margin with two teeth, or rather angles, which, however, vary much in size; rostrum very prominent. Anterior legs in male large, equal; hand and wrist much swollen, fingers curved and armed with hairs along their inner margin; in the female these legs are slight and their fingers almost straight. Ambulatory legs very flat; anterior margin of first joint produced so as to form a very prominent point, almost a spine; claws half the length of preceding joint. Whole animal destitute of hair, except on the fingers. First and second pairs of ambulatory legs very long, more than twice the length of the carapace. Breadth $\frac{5}{8}$ inch, length $\frac{4}{8}$.

Hab. Wellington.

LIII.—*Studies on Fossil Sponges.*—II. *Lithistidæ.* By Karl Alfred Zittel.

[Concluded from p. 394.]

Family 4. **Tetracladina.**

Aulocopium, Oswald, 1846.

(Schles. Gesellsch. für vaterl. Cultur, 1847, p. 58; F. Römer, Foss. Fauna von Sadewitz, 1861, p. 2.)

Sponge free (not attached), hemispherical, rarely globular or top-shaped, with impressed central cavity; lower surface coated with a wrinkled dense siliceous membrane. From the lower extremity of the central cavity numerous water-canals radiate to the periphery; curved canals of larger diameter, parallel to the contour line, open into the stomachal cavity. Skeleton formed of smooth, irregular, quadriradiate elements, each ray branched root-like at the end. These are usually arranged in rows so that the ramified ends of two neighbouring rows meet in a plane parallel to the radial canals, greatly enhancing the radiate appearance seen in a transverse section of the sponge-body.

The *Aulocopia* occur as chalcedonic pebbles in the North-German diluvium, especially on the island of Sylt. The microscopic structure is then generally well preserved, and may be shown in thin slices. In other places, as at Sadewitz, the whole sponge is filled with calc spar, and the originally siliceous skeleton converted into calc spar. The same unfavourable conditions prevail in specimens obtained *in situ* from the Silurian beds of Esthonia, sent by Prof. F. Schmidt of St. Petersburg. In those from Sadewitz the upper part is sometimes calcified, and the lower, so far as the wrinkled membrane extends, converted into chalcedony. All the species are Silurian :—

1. *Aulocopium aurantium*, Osw., in F. Röm. Sad. p. 4, Taf. ii. fig. 1 *a–c*.
2. *Aulocopium diadema*, Osw. ib. p. 5, Taf. i. fig. 1 *a–c*.
3. *Aulocopium hemisphæricum*, F. Röm. ib. p. 6, Taf. ii. fig. 3.
4. *Aulocopium cepa*, F. Röm. ib. p. 7, Taf. ii. fig. 2.
5. *Aulocopium discus*, F. Röm. ib. p. 8, Taf. iii. fig. 1.
6. *Aulocopium cylindraceum*, F. Röm. ib. p. 9, Taf. iii. fig. 2.

PHYMATELLA, Zitt.

Scyphia p. p., Röm., Mich., Court.
Siphonia p. p., Reuss.
Eudea p. p., *Cylindrospongia* p. p., *Hippalimus* p. p., Röm.
Polythyra, *Hypothyra*, ?*Physocalpia*, Pom.

Sponge simple, cylindrical, pyriform, flask-shaped or nodular, sessile or long-stalked, with a deep central cavity reaching far towards the root, and near the base pad-like or nodular excrescences, separated by depressions, at which the wall is often broken through. Surface with numerous irregularly scattered circular or oval ostia of various sizes, from which simple radial canals pass into the wall. Similar horizontal canals commence near the surface, and open into the central cavity. Skeleton of regular quadriradiate corpuscles of considerable size, having the four main arms smooth and round, and their ends divided into several branches with short root-like processes. In well-preserved specimens the surface has a coat of elegant forked anchors; and among the corpuscles there are numerous uniaxial pointed or blunt spicules of various sizes.

Some species have a cylindrical stalk, 50–80 millims. in length, on which there are no ostia, but which contains vertical tubes and has a quite different microstructure. To the naked eye the stalk appears composed of long somewhat curved fibres parallel to the long axis. Under the microscope these fibres are shown to be long, distorted, Lithistid corpuscles, one ray being enlarged at the expense of the others, which are reduced to small lateral branches, which become weaker and weaker below. In the upper part of the stalk there are, between the fibres, small, indistinctly quadriradiate, strongly ramified, Lithistid corpuscles. All the species are from the Upper Cretaceous.

*1. *Eudea intumescens*, Röm. Spong. xi. 1, *Cuvieri*-Pläner; Quenst. Petr. cxxxiii. 23–26.

*2. *Cylindrospongia heteromorpha*, Röm. ib. viii. 11. *Cuvieri*-Pläner.

3. *Scyphia heteromorpha*, Röm. Kr. ii. 3. *Quadratus*-chalk.

*4. *Phymatella bulbosa*, Zitt., sp. n. Polymorphous, strongly thickened and furnished with nodular excrescences at the base, stalkless. Central cavity of various widths. Tolerably frequent in the *Quadratus*-chalk of Biewende and in the *Mucronatus*-chalk of Ahlten.

5. *Spongites plicatus*, Quenst. Petr. cxxxiv. 1, 2. Pläner, Oppeln.

6. *Spongites tuberosus*, Quenst. ib. p. 388, cxxxiii. 18–20. Senonian.

7. *Hippalimus lobatus*, Röm. Spong. x. 1. Senonian.

8. ?*Hippalimus depressus*, Röm. ib. x. 2. Senonian.

*9. *Siphonia elongata*, Reuss, Kr. xxxiv. 1. Cenomanian.

*10. ?*Actinospongia dichotoma*, Röm. Spong. xix. 4. *Cuvieri*-Pläner.

11. *Scyphia trilobata*, Mich. Ic. xxviii. 2. Cenomanian.

12. *Scyphia attenuata*, Court. Ep. v. 2. Senonian.

13. *Scyphia perforata*, Court. ib. v. 3. Senonian.

14. *Scyphia conica*, Court. ib. v. 7. Senonian.

Also, perhaps, *Scyphia echinata*, *mammillata*, *sphærica*, *coronata*, *digitata*, Court. ib. pl. vi. Senonian.

Aulaxinia, Zitt.

Siphonocœlia p.p., Röm.

Sponge from elongate-pyriform to cylindrical, stalked. Vertex with a very shallow broad depression, from which run strong furrows, passing down the sides of the sponge to the beginning of the stalk. Interspaces about equal in breadth to the furrows, with rows of round ostia, from which canals penetrate into the dense sponge-body. Root without ostia, generally simple.

Body-skeleton like that of *Phymatella*. Forked anchors with long shafts and large bacillar spicules seem to indicate a special surface-layer. The root consists of very irregularly distorted quadriradiates, in which one arm is elongated and contains the axial canal; towards the lower end of the stalk the surface is covered with very long fibres, having numerous short lateral branches (Pl. VIII. fig. 2). In these, also, the axial canal is short and closed at both ends.

*1. *Siphonocœlia sulcifera*, Röm. Spong. xi. 7. From the Upper Cretaceous of Linden, Ahlten, and Dolberg, near Hamm.

Callopegma, Zitt.

Cupulospongia p. p., auct.

Sponge basin- or funnel-shaped, sessile or short-stalked, thick-walled; outer surface with round pores; inner surface in the centre sometimes with larger oscula, from which vertical canals penetrate into the sponge. Skeleton coarsely meshed, loose, composed of large, rather regular quadriradiates with smooth arms, the ends of which are strongly branched (Pl. VIII. fig. 1); the short canals of the four arms meeting in the middle. Surface, in well-preserved specimens, coated with forked anchors, their long shaft turned inwards. Also numerous bacillar spicules of different forms and sizes, and a few small anchors with recurved simple prongs.

Two species from the Upper Cretaceous of North Germany and Belgium.

1. *Callopegma acaule*, Zitt. Basin-shaped to hemispherical, either free or attached by a short wart-like stalk. Very thick-walled; in the bottom of the depressed upper surface several large round oscula. Outer wall porous. Under surface with some tubercles. Ahlten, Linden, Ciply.

2. *Callopegma Schlönbachi*, Zitt. Basin- or funnel-shaped; central cavity very wide and deep; attached by a broad base. *Mucronatus*-chalk, Ahlten.

Trachysycon, Zitt.

Plocoscyphia p. p., Röm.
Sporocalpia p. p., Pomel.

Sponge from ficoid to elongate-ovate, stalked, with a tubular central cavity, on the wall of which are the ostia of the rather coarse radial canals. Surface with conical pointed warts, from the apices of which fine furrows radiate. Stalk and lower part of the sponge-body smooth, furnished only with pore-like ostia, sometimes coated with a wrinkled siliceous membrane. Corpuscles large, irregularly quadriradiate. The four thick arms short and smooth, divided at the ends into several knotty branchlets.

1. *Trachysycon* (*Plocoscyphia*) *muricatum*, Röm. Spong. p. 20, x. 9. From the *Quadratus*-chalk of the Sutmerberg. Pomel refers to it under the name of *Sporocalpia*; but in this genus are united a true Hexactinellid (*Plocoscyphia morchella*, Röm.) and the present Lithistid.

SIPHONIA, Park., 1822 *.

Caricoides, Guett.
Siphonia p. p., Park. et auct.
Choanites p. p., Mant.
Hallirhoa, Lamx.
Siphoneudea and *Polysiphoneudea*, From.
Siphonia, Hallirhoa, Angidia p. p., *Plethosiphonia, Polysiphonia, Pterocalpia, ?Physocalpia*, Pomel.

Sponge ficoid, pyriform or pomiform, sometimes rendered lobular by constrictions, generally simple, with short or long stalk, rarely stalkless. Vertex with a deep central cavity, on the wall of which are the round ostia of efferent canals, usually arranged in longitudinal and transverse rows. These rather wide canals are curved parallel to the outer contour of the sponge, but become more and more upright towards the middle, and finally vertical, being continued into the stalk and root as bundles of tubes. The curved canals decrease in size outwards, and commence at the surface in several fine tubercles, which unite and then run to the cloaca. Numerous smaller afferent canals run obliquely from within outwards, cross the curved canals, and commence at the surface in depressed round ostia.

Skeleton formed of large, distinctly quadriradiate corpuscles. The arms are smooth or slightly tubercular; their ends divide into two, three, or more branches with root-like processes. The corpuscles are usually arranged serially along the course of the canals; and their thickened and interlocked ends form regular radial bands †. Large bacillar spicules occur at the surface, in the canals, and in the skeleton; anchors with forked prongs are rare.

Many species of this genus change their form as they increase in size. Young specimens are generally cylindrical and traversed by nearly vertical tubes. The changes are figured by Sowerby (Geol. Trans. ser. 2, vol. v. pl. xv.) in *Siphonia tulipa*.

Externally *Siphonia* very closely resembles *Jerea*. The

* Mr. Sollas has published a paper in the Quart. Journ. Geol. Soc. vol. xxxiii. p. 790, in which he treats of the structure and affinities of the genus *Siphonia*. The author remarks that he agrees with Mr. Sollas in all essentials, and that the latter has given fuller particulars on some points than will be found in the first section of the present memoir. The author separates *Jerea* from *Siphonia*, which Mr. Sollas has not done.

† The microstructure of the root agrees generally with that of the rest of the skeleton, except in the species with long stalks, in which the arms of the corpuscles, or one of them, are much elongated. See also Sollas, *loc. cit.*

sole distinction is the presence in *Siphonia* of a depressed central cavity, into which the ostia of the curved main canals open; but when the central cavity is broad and shallow, the canals also become more upright, and forms are produced which immediately approach *Jerea*. The structure of the skeleton is the same in the two genera.

This relationship of the two genera is reflected in the literature of the subject. Parkinson's diagnosis of *Siphonia* applies equally well to both; and among his species are two *Jereæ*. Of the three original species of Mantell's *Choanites*, two belong to the Hexactinellidæ; the third (*C. Königi*) is a *Siphonia*. In 'Medals of Creation' (2nd ed. pp. 230, 233), Mantell separates *Choanites* and *Siphonia*, distinguishing the former by the absence of a stalk furnished with tubes. By most subsequent authors *Choanites* is dropped and united with *Siphonia*. Cunnington, indeed (Institut, 1849, xvii. p. 14), finds generic distinctions in the deep central cavity and a supposed spiral canal; but no such canal is to be seen in the figures of Mantell and Dixon, or in specimens from England. Goldfuss, F. A. Römer, Reuss, D'Orbigny, &c. combine very different sponges under *Siphonia*; Courtiller refers to it a great many true *Jereæ*; while Fromentel and Pomel place the two genera in different families, and divide each of them into several genera. Parkinson's name is retained for these sponges, because it has been almost without exception employed for the typical species (e. g. *Siphonia piriformis*, *tulipa*, *ficus*, *nuciformis*, &c); and these species would certainly have been included by Parkinson under *Siphonia*. The genus is confined to the Cretaceous formation. The lobate forms may constitute a special subgenus (*Hallirhoa*, Lamx.).

A. Of typical *Siphoniæ* may be mentioned:—

1. *Siphonia piriformis*, Goldf. vi. 7 *a*; Mich. Ic. xxxiii. 1. Senonian.

2. *Siphonia tulipa*, Zitt. *. Cenomanian, Blackdown.
Siphonia piriformis, Sow. Geol. Trans. ser. 2, vol. vi. pl. xv. *a*.
Siphonia Websteri, Quenst. (non Sow.), Petr. cxxxv. 15–19.

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* This species, which is very abundant in the Greensand of Blackdown and Halden, has received a new name. It is generally united with *Siphonia piriformis*, Goldf., but is distinguished by the sudden constriction of the pyriform head immediately above the very long slender stalk, by the coarse curved and radial canals, and by the microstructure of both the head and the stalk. Quenstedt has separated it from *S. piriformis*, but identified it, erroneously, with *Jerea Websteri*, Sow., of which Sollas has lately given a good description and figures. *Siphonia Fittoni*, Mich., is more nearly allied to *S. piriformis*, Goldf., than to *S. tulipa*.

3. *Siphonia Geinitzi*, Zitt. Cenomanian.
Siphonia pyriformis, Gein. Elbth. i. p. 38, Taf. 9, 10. fig. 4.
4. *Siphonia bovista*, Gein. ib. x. 5, 6. Cenomanian.
5. *Siphonia ficus*, Goldf. lxv. 14. Senonian.
6. *Choanites Kœnigi*, Mant. Geol. Suss. xvi. 19–21. Upper Chalk.
7. *Siphonia incrassata*, Goldf. xxx. 5. Senonian.
8. *Siphonia nuciformis*, Mich. Ic. xxxiii. 4. ? Cenomanian.
9. *Siphonia multioculata*, Mich. ib. xxxiii. 6. Turonian.
10. *Siphonia arbuscula*, Mich. ib. xxxiii. 2. Turonian.
11. *Siphonia ficoidea*, Mich. ib. xxix. 5. Cenomanian.
12. *Siphonia acaulis*, Mich. ib. xxxviii. 2. Cenomanian.
13. *Siphonia ornata*, Röm. Spong. x. 9. *Quadratus*-chalk.
14. *Siphonia Morrisi*, Mant. Med. ed. 2, p. 254. Upper Chalk.
15. *Siphonia Fittoni*, Mich. Ic. xxix. 6. Senonian.

Also numerous, mostly ill-characterized, forms described by Courtiller, e. g. *S. decipiens*, *osculata*, *parasitica*, *sphærica*, *curta*, *cylindrica*, *intermedia*, *conica*, *rariosculata*, &c., many probably identical with previously described species.

B. Subgenus *Hallirhoa*, Lamx.

1. *Hallirhoa costata*, Lamx. Mich. Ic. xxxi. 3. Cenomanian.
2. *Hallirhoa brevicostata*, Mich. ib. xxxi. Cenomanian.
3. *Hallirhoa Tessonis*, Mich. ib. xxxiv. 1. Cenomanian.

Here also probably *Scyphia alata* and *palmata*, Court.

Jerea, Lamx.

(Expos. Méth. p. 79.)

Siphonia p. p., *Jerea* p. p., auct.
Manon p. p., Goldf.
Rhysospongia, *Jerea*, *Cupulina*, *Siphonia* p. p., Court.
Polypothecia p. p., Benett, Mich.
Jerea p. p., *Rhizospongia* (*Rhysospongia*), D'Orb.
Jerea, *Polyjerea* p. p., *Rhizospongia*, *Rhizostele*, *Rhizogonium*, Pom.

Sponge pyriform, globular, reversed flask-shaped, conical or cylindrical, simple, rarely forming branched stocks, with a short or long stalk, and more or less thickened, sometimes dilated or branching base. Vertex truncate or with a depression, always with a number of round apertures, the orifices of a bundle of vertical tubes which traverse the whole sponge to its base, either perpendicularly or more or less parallel to the outer surface. Surface with numerous, unequal, scattered small ostia, from which canals run to the centre of the sponge. These ostia gradually disappear on the stalk.

Skeleton composed of four-armed corpuscles of considerable size; the arms usually smooth near the point of union, but sometimes with blunt processes; their ends more or less branched, sometimes even enlarged into interlocked balls. In some species the arms, or some of them, divide into two main branches. Isolated forked anchors and simple bacillar spicules occur.

The genus was well characterized by Lamouroux in 1821. Goldfuss describes several species under the names of *Jerea*, *Siphonia*, and *Manon*; and Michelin also mixes *Siphonia* and *Jerea*; but D'Orbigny rather limits Lamouroux's conception, and separates the forms with a dilated root under the name of *Rhysospongia*. Such roots had previously been referred by Michelin to *Polypothecia*. Fromentel separated the compound forms as *Polyjerea*; and Courtiller and Pomel divide *Jerea* into several genera. The former retains the name only for those with a truncate vertex; those with a depression form the genus *Cupulina*. Many true *Jereæ* are also referred by him to *Siphonia*, and those with a large root to *Rhysospongia* D'Orb. As the supposed epitheca of *Rhizospongia* has no existence, that genus is superfluous, as also *Rhizostele*, *Rhizogonium*, and *Rizogonima*, Pom. Pomel divides the compound *Jereæ* into several genera; *Polyjerea* is retained for the forms with basal prolification, such as *J. cæspitosa* and *gregaria*, Mich., *S. ternata*, Reuss, &c.; *Callojerea* and *Dichojerea* are proposed for the branched forms, and, being founded solely upon external characters, include very heterogeneous elements.

The genus *Jerea* first appears in the Cretaceous, and possibly extends into the Miocene, if some of Pomel's species really belong to it. As typical species may be cited:—

*1. *Jerea pyriformis*, Lamx. Exp. p. 79, lxxviii. 3. Cenomanian.

> *Jerea pyriformis* and *elongata* p. p., Mich. Ic. xxxvi. 3, and xxxix. 4.
> *Jerea amygdaloidea*, Gümb. Ostb. Grenzgeb. p. 771.

2. *Alcyonolithes stadensis*, Blum. Spec. Arch. Tell. ii. figs. 5, 6.

> *Siphonia cucumis*, Menke, Jahrb. 1841, ii. fig. *c*.
> *Siphonia Kraussi*, Hag.
> *Jerea pyriformis* and *elongata* p. p., Mich. *l. c.*
> *Jerea pyriformis* and *intricata*, Court. Ep. xxxiv. 2, 3.

3. *Jerea Quenstedti*, Zitt., *Quadratus*-chalk, Linden, near Hanover.

> *Siphonia ficus*, Quenst. Petr. cxxxv. 20–23.

Allied to the above are :—

4. *Siphonia prolifera, clavata, acuta, polycephala, difformis, coronata, acaulis*, and *Cupulina elata, pocillum, latiosculata, glomerata, rhysospongioides, elongata, parallela, ficoidea, capitata*, and *acaulis*, Court. Ep. xxix., xxx.

5. *Siphonia ternata*, Reuss, Böhm. Kr. xvii. 1, 3. Turonian.

6. *Jerea excavata*, Mich. Ic. xxxiii. 3, xxxix. 2.

Polypothecia pictonica, Mich. ib. xxxvii. 1.
Jerea tuberosa, Mich. ib. xxxix. 3.
Rhysospongia pictonica, pateræformis, cyathiformis, vestita, crassa, elongata, semiglobosa, clavata, attenuata, truncata, costata, and *digitata*, Court. Ep. i.–iv.

7. *Siphonia multiformis*, Bronn, Leth. Geogn. xxvii. 20. Peine.

Marginospongia, D'Orb.

(Prodr. ii. p. 187.)

Alcyonium, Lamx.
Chenendopora p. p., Mich.
Marginojerea, From.
Marginospongia, Placojerea, Pom.

Sponge cup- or funnel-shaped, stalked. Upper margin with numerous round apertures of tubular vertical canals, which traverse the whole wall and the stalk. Skeleton ? Only in the Cretaceous.

1. *Alcyonium infundibulum*, Lamx. 1830 (teste D'Orb.).
Chenendopora Parkinsoni, Mich. Ic. xxxi. 1. Cenomanian.

2. *Marginospongia irregularis*, D'Orb. Prodr. Et. 22, no. 1500. Senonian.

? 3. *Jerea Desnoyersi*, Mich. Ic. xxxix. 1.

Nelumbia, Pom.

(Pal. d'Oran, p. 194.)

Polystoma p. p., Court.

Sponge clavate, stalked; vertex truncate or with a slight depression, covered with round ostia of vertical canals, which do not penetrate very deeply into the sponge-body. Sides with scattered depressions, into which open short, tortuous or straight transverse canals. According to Courtiller the sponge is sometimes covered with a delicate siliceous skin. Skeleton as in *Jerea*, of which this is perhaps only a section. The genus is limited to the Upper Cretaceous. Courtiller (*l. c.* pl. xv.) figures several forms, probably belonging to a single species, as constituting a section of his genus *Polystoma*.

Polyjerea, From., emend. Zitt.

Jerea, Mich.
Siphonia p. p., Court.
Jerea p. p., D'Orb.
Polyjerea, Dichojerea p. p., Pom. (non *Polyjerea,* Röm.).

Sponge compound, tufted or branched, rarely simple, the cylindrical or barrel-shaped individuals often united at their base, with rounded vertex, in which are several apertures of vertical canals, which traverse the whole sponge-body. The base and the whole, or a great part, of the sponge covered with a smooth siliceous epidermis, beneath which are the ostia of the small radial canals. Skeleton, as in *Jerea,* chiefly composed of large, smooth quadriradiates, with branched ends; and of very small, elegantly filigreed, indistinctly quadriradiate, siliceous corpuscles, which lie close together at the surface and form the skin.

Increase takes place either by basal or by lateral budding, producing either bushy or arborescent forms. The distinction from *Jerea* consists in the small development of the radial canals and the presence of the epidermis. Nearly all Römer's species of *Polyjerea* belong to *Jerea. Polyjerea* is nearly allied to *Thecosiphonia,* in which, however, the epidermis is confined to the lower part, the individuals are larger, the vertical canals are much more numerous and open into a depression, and the radial canals are much better developed.

The typical species is very abundant in the Senonian near Evreux.

1. *Polyjerea ramifera,* Zitt., distinguished from *Jerea gregaria* and *cæspitosa* by the more distinct separation and furcation of the branches.

There also belong here :—

2. *Jerea arborescens,* Mich. Ic. xlii. 2 *a* (non 2 *b*). Senonian.

3. *Jerea gregaria,* Mich. ib. xxxviii. 1. Senonian.

4. *Jerea cæspitosa,* Mich. ib. lxi. 4. Senonian.
Siphonia arborescens, Court. Ep. xxiv. 2.

Astrocladia, Zitt.

Siphonia p. p., Mich.
Asterospongia p. p., *Stellispongia* p. p., Röm.
Callojerea p. p., Pom.

Sponge cylindrical, or arborescent by dichotomous ramification, massive, with no central cavity. Surface with a smooth (apparently dense) covering-layer, in which are distant oscula, which usually consist of some short fine tubes opening into a small common depression or elevation. Oscula often stellate in appearance, owing to fine radial furrows on the surface of the true skeletal mass. Besides the oscula the surface under the covering layer is furnished with fine pores, the orifices of small radial canals. A few fine vertical tubes run through the whole sponge-body in the direction of its axis. Skeleton of small distinctly quadriradiate corpuscles with a short axial cross; arms smooth, strongly ramified at the ends. The nearly dense covering layer is formed of very small, closely interlocked, strongly branched, irregular lithistid corpuscles, and is easily scaled off. No special surface-spicules observed.

*1. *Asterospongia lævis*, Röm. Spongit. xix. 2. *Cuvieri*-Pläner.
*2. *Asterospongia subramosa*, Röm. ib. xix. 3. *Quadratus*-chalk. Sutmerberg, Ahlten.
*3. *Stellispongia verrucosa*, Röm. ib. xvii. 5. *Quadratus*-chalk.
4. *Siphonia ramosa*, Mich. Ic. xxviii. 5; Court. Ep. xxiv. 1.
*5. *Tremospongia clavata*, Röm. Spong. xiii. 13. *Cuvieri*-Pläner.

THECOSIPHONIA, Zitt.

Lymnorea p. p., *Tremospongia*, F. A. Röm.
Tremospongia, Gein. (non D'Orb.).
Diestosphecion p. p., *Cytorea* Pom.
Polyjerea p. p., From.

Sponge simple or compound, individuals large, elongate, top-shaped or cylindrical; vertex with a shallow depression, into which opens a bundle of vertical tubular canals. Of these canals the uppermost run nearly parallel with the periphery, causing radiating furrows on worn specimens; those in the middle traverse the sponge nearly perpendicularly. There are also radial canals running obliquely inwards and downwards, the round ostia of which are scattered over the surface, which is rough, with crooked furrows and pits. Base simple or with root-like processes, coated, as well as a larger or smaller part of the sponge-body, with a dense siliceous covering layer. In compound stocks this epitheca unites all the individuals. Skeletal elements of considerable size, regularly four-armed; the arms smooth, with ramified ends. Bacillar spicules scattered in the skeleton.

This genus is nearly allied to *Siphonia* and *Jerea*, but is distinguished by its strongly developed covering layer, and its larger and more regular skeletal elements. Good figures are given by Quenstedt (Petr. cxxxiii. 8–11).

*1. *Lymnorea nobilis*, Röm. Spong. xv. 1. *Cuvieri*-Pläner.

*2. *Tremospongia grandis*, Röm. ib. xv. 3. *Cuvieri*-Pläner.

3. *Tremospongia Klieni*, Gein. Elbth. i. p. 28, pl. iv. fig. 3. Cenomanian.

Calymmatina, Zitt.

Cnemidium p. p., *Scyphia* p. p., Mich.
Turonia p. p., D'Orb.
?*Pseudosiphonia*, Court.

Sponge compound or simple. Individuals top-shaped, shortly cylindrical or nodular, usually united into stocks by basal amalgamation. Wall thick; vertex rounded, with a simple central cavity. Base often with processes, thick or narrowed into a stalk. The whole sponge clothed with a dense, smooth or wrinkled, siliceous skin, which, however, is usually rubbed off on the vertex and upper parts of the sides. These rubbed parts are roughened by irregular, short, longitudinal and transverse furrows, in the bottom of which are the ostia of simple radial canals, which become finer within. Similar canals run in the opposite direction from without towards the central cavity. Skeleton of two kinds of elements:—1, rather large quadriradiate Lithistid corpuscles, with strongly branched ends, and gnarled or smooth arms; 2, very small, gnarled irregular corpuscles, which lie in the interstices of the larger elements. At the surface these are very closely packed and form the covering layer. Sometimes the latter contains elegant forked anchors; and numerous bacillar spicules are scattered in the skeleton and canals.

This genus is most nearly allied to *Turonia*, Mich. The known species are all from the Upper Cretaceous of Touraine.

1. *Scyphia sulcataria*, var. *inflata*, Mich. Ic. xxviii. 4. Senonian.

Cnemidium crassum, Mich. ib. xxviii. 3.

*2. *Calymmatina rimosa*, Zitt. Senonian.

Scyphia dichotoma, Mich. ib. xxviii. 5 (non Benett).

? 3. *Pseudosiphonia tuberculata*, Court. Ep. xxviii. 1, 2. Senonian.

Turonia, Mich.

(Icon. Zooph. p. 125, 1846.)

Turonifungia, From.
Hippalimus p. p., Röm.
Turonia, Pom.

Sponge very irregular, nodular or biconical, the base, the lower half, or nearly the whole surface, with an apparently smooth covering layer as thick as thin paper. The parts not covered with this layer rough, sometimes traversed by radiating furrows issuing from one or more shallow depressions; at the vertex tubular vertical canals open into these furrows. Skeletal corpuscles rather large, smooth, quadriradiate, united by short, thick, root-like ramifications, forming thickened nodes, in which the ends of four arms usually unite. Corpuscles with a fine axial cross. The covering layer consists of small, flat, indistinctly triradiate corpuscles, covered with processes, and very closely packed together, and of forked anchors, the three prongs of which are long, widely forked and spread in a plane, so as usually to lie quite on the surface. Large bacillar spicules are scattered upon the parts not covered by this layer. All the species are from the Upper Cretaceous.

1. *Turonia variabilis*, Mich. Ic. xxxv. 1–8. Senonian, Touraine.

T. variabilis and *sulcata*, Court.

2. *Turonia constricta*, Zitt., sp. n. Irregularly pyriform, with broad, almost horizontally truncate base, furnished with numerous blunt tubercles and depressions. Upper part elongated, bluntly conical, with irregular transverse constrictions; in the vertex usually a shallow depression from which furrows originate, which run down the sides, and divide below into fine branches. The smooth covering layer generally coats only the base. Abundant in the *Mucronatus*-chalk of Åhlten.

3. *Turonia induta*, Zitt., sp. n. Small, nodular or lobate, almost entirely coated with epidermis. *Quadratus*-chalk, Linden.

? 4. *Hippalimus depressus*, Röm. Spongit. x. 2. Senonian.

Theonella, Gray.

(Proc. Zool. Soc. 1868, p. 565.)

(*Recent.*) Cup-shaped, thick-walled; central cavity simple, base broad. Skeleton of small quadriradiates with strongly branched ends. Surface anchors with a short shaft and three forked, curved, horizontal prongs.

1. *Theonella Swinhoei*, Gray. Formosa.

2. *Dactylocalyx Pratti*, Bow. P. Z. S. 1869, p. 89, pl. v. figs. 6–11.

3. *Theonella ferruginea*, Häck. The skeletal corpuscles of this species have smooth branches.

RHACODISCULA, Zitt.

Corallistes p. p., Schmidt.
? *Dactylocalycites*, Cart.

Clavate, nodular, cylindrical or cup-shaped. Skeleton formed of irregularly quadriradiate corpuscles, their arms much branched at the ends. Surface with short-stalked, lobate, siliceous disks. Recent and Cretaceous.

1. *Rhacodiscula asteroides*, Cart. Ann. & Mag. Nat. Hist. 1873, vol. xii. p. 441.

Corallistes polydiscus p. p., Schm. (non Bocage), Atl. Sp. iii. 8, 9. Florida.

2. *Rhacodiscula*, sp. n. Philippines. See Cart. Ann. & Mag. Nat. Hist. 1876, xviii. p. 464.

?3. *Dactylocalycites Vicaryi*, Cart. Ann. & Mag. Nat. Hist. 1871, vol. vii. pl. vii. figs. 1, 2, 6. Cenomanian, Haldon.

DISCODERMIA, Bocage.

(Journ. Sci. Lisb. 1869, no. 4, pl. xi. fig. 1.)

Cup-shaped. Skeletal corpuscles quadriradiate, with much-ramified ends. Both surfaces covered with entire (or much-notched), very short-stalked, siliceous disks. Recent and Cretaceous.

1. *Discodermia polydiscus*, Boc. *l. c.*, and Bow. P. Z. S. 1869, p. 96, pl. vi. figs. 10–14. Portugal, Cuba, Florida.

?2. *Dactylocalycites callodiscus*, Cart. Ann. & Mag. Nat. Hist. vol. vii. 1871, pl. ix. figs. 40–42. Cenomanian, Haldon.

?3. *Dactylocalyx*-ähnliche Scheiben, Zitt. Cœlopt. v. 32–35. Senonian, Haldem, Vordorf.

KALIAPSIS, Bow.

(P. Z. S. 1869, p. 338, pl. xxv. figs. 2–5.)

(*Recent*). Incrusting, thin, without oscula and pores. Skeleton of smooth-armed quadriradiates, with the ends finely ramified and filigreed. In the corpuscles of the base the arm that is directed downwards is not ramified, but pointed. Surface covered with much-notched or entire disks, granulated in the centre, and furnished with a short stalk.

1. *Kaliapsis cidaris*, Bow. *l. c.* Pacific.

RHAGADINIA, Zitt.

Cupulospongia p. p., Röm.

Sponge ear-shaped, flat, or basin-shaped, attached laterally by a short stalk. Wall thick; margin rounded off. Both surfaces with anastomosing furrows, which are either quite irregular or show an indistinct radial arrangement, sometimes forming indistinct stellate figures. From these furrows canals run straight or obliquely into the wall. The four arms of the skeletal corpuscles are divided each into two or more rather long warty branches, the ends of which are again repeatedly notched. Some of the corpuscles are pretty uniformly tubercular; others have the arms near the centre smooth or with a few tubercles. On the surface there is a complete coat of smooth large and small corpuscles of peculiar structure. The larger have a spiniform shaft, from the thickened end of which issue three broad horizontal arms, divided into two, three, or more deeply cleft lobes; in the centre of each corpuscle is a quadriradiate axial cross. These lobate disks are bound together by a network of small, smooth-armed, irregular siliceous bodies.

The only known species of this genus is described by Römer (Spong. p. 51, xvii. 8) as *Cupulospongia rimosa*. The numerous specimens from the Upper Cretaceous of Ahlten, however, will have to be divided into two or three species. Individual specimens attain a breadth of 130–150 millims., with walls 30 millims. thick.

Plinthosella, Zitt.

?*Achilleum* and *Amorphospongia* p. p., Röm.

Sponge globular or irregularly nodular, free or attached by a short stalk, without a central cavity. Surface with irregularly distributed furrows and scattered apertures, connected with more or less deep curved canals. The whole sponge-body consists of a loose coarse texture of quadriradiate corpuscles of considerable size. These corpuscles are covered with rounded gnarled warts; and the arms are but slightly, if at all, branched. Surface covered with a thick layer of imbricated siliceous scaly plates of irregular form—roundish, polygonal or elongated, lobate or with long processes. Their surface is roughened. Only in the Cretaceous.

1. *Plinthosella squamosa*, Zitt.

?*Achilleum deforme*, Röm. Kr. p. 2.

Globular bodies 5–25 millims. in diameter. Skeleton beneath the scaly layer traversed by furrows and furnished with rounded ostia. *Quadratus*-chalk of Ahlten and Linden in Hanover.

Spongodiscus, Zitt.

Turonia p. p., Court.
Lithosia p. p., Pom.

Sponge disciform, lenticular, or hemispherical, with a rounded or rounded-hexagonal periphery. Margin acute. One surface (rarely both) slightly convex, the other flat and covered with radiating ribs. Skeletal corpuscles large, quadriradiate, covered with roundish warts, the ends of the arms not branched, but only thickened, or at the utmost slightly forked. The ends are applied to each other; and thus is formed a wide-meshed skeleton in which the water can circulate freely. No special canal-system. Isolated large bacillar spicules occur. Two species from the Upper Cretaceous:—

1. *Spongodiscus radiatus*, Zitt.

Turonia radiata, Court. Ep. xl. 9, 10.

Disciform. Upper surface with radial ribs and furrows; under surface slightly convex, smooth. Frequent in flint nodules of Touraine and the neighbourhood of Rouen. Orig. ex. in the museum of Geneva.

2. *Turonia mammillata*, Court. ib. xl. 7, 8. Touraine.

LIV.—*Descriptions of two new Species of Land Shells from New Granada.* By Edgar A. Smith, F.Z.S.

Cyclotus corpulentus.

Shell depressed, suborbicular, openly umbilicated, dark olive-brown, lighter or less olive on the upper whorls, and lighter also on the lower surface of the last whorl than on the upper part. Apex generally rather eroded, reddish. Whorls five, very convex, rapidly enlarging, rather coarsely and obliquely striated with the lines of growth; last whorl large and ventricose, almost free from the penultimate at the aperture. Suture rather deep, distinctly channelled in front. Aperture very large, subcircular, livid bluish. Peristome simple, pale within at the margin; columellar side a little expanded towards the umbilicus, whitish, joined to the upper or outer margin by a callosity, which is generally broken irregularly at the edge, and obliquely nearly rectilinear or but little curved. Operculum almost flat, with only a slight depression in the centre, white, thickish, consisting of seven whorls, exclusive of the dark nucleus. Greatest breadth 35 millims., least breadth 25, height 19; aperture 18 millims. wide at its greatest diameter.

Hab. San Sebastian, New Granada (*F. A. Simons*).

This species is remarkable for the swollen character of the last volution. Besides the dark olive-brown general colour of the shell, on close inspection numerous narrow dark spiral lines may be observed encircling the last whorl. This is white beneath the epidermis, as may be seen on the front part, where a small spot is generally denuded from having been trailed along the ground by the animal. The types of this and the following species are in the British Museum.

Helicina colombiæ.

Shell trochoid, acutely keeled at the middle of the last whorl, yellow, banded with clouded purplish pink round the lower part of the upper whorls and above and below the carination; the band or zone below the keel narrower than the upper one. Whorls $5\frac{1}{2}$–6, but very little convex, rather coarsely spirally striated, obliquely marked with very faint wavy lines of growth, and most minutely striated or scratched obliquely in an opposite direction; last whorl beneath the carina a trifle convex. Aperture subtriangular, displaying the colours of the exterior. Lip lemon-yellow, shortly expanded and reflexed, especially at the basal margin and towards the columellar region, where it is reflected so as to almost touch the whorl; columella short, arcuate, whitish; columellar callus broadly spread, whitish, extending to the upper termination of the peristome. Height $8\frac{1}{2}$ millims., greatest breadth $13\frac{1}{2}$, least diameter $11\frac{1}{3}$; aperture 5 millims. long, 6 wide from the carina to the columella.

Hab. San Sebastian, New Granada (*F. A. Simons*).

The central keel is whitish and falls just above the upper extremity of the outer lip, and consequently, as the last whorl does not descend, runs just above and parallel with the suture and is distinctly visible some distance up the spire. The form of this pretty species, of which only a single specimen was collected, is somewhat peculiar, the spire being rather elevated in proportion to the portion of the shell below the keel. Besides the very faint and most minute wavy lines of growth above referred to, which are only visible under a powerful lens, there are others quite observable by the naked eye. Although I have described the last whorl as ornamented with two purplish-pink bands, it might equally well be said to have but a single broadish zone subdivided by the acute central carina, which is whitish.

LV.—*On the* Willemoesia *Group of Crustacea.* By C. Spence Bate, F.R.S.

My paper on these Crustacea in the October number of the 'Annals' was never intended to be exhaustive of the subject; but I certainly think that it was sufficiently clear to have precluded questions and criticisms that without difficulty might have been settled by one who has the advantage of being in possession of specimens of the group.

The Rev. A. M. Norman says ('Annals,' November, p. 382), "I do not see my way at present to acquiescing in his conclusions, and therefore venture to ask him to give us further information."

His first question is, "Are his genera *Pentacheles* and *Willemoesia* any thing more than the other sex of *Polycheles?*"

Having just given a paper to prove that they are distinct and not one and the same species, I beg to repeat that *Pentacheles* and *Willemoesia* are not the other sex of *Polycheles*, and to refer him to my paper for details.

The next question is, "Has not my friend mistaken *sexual for generic characters?*" to which I reply, most certainly not. Then he asks, "Has he male and female of any *Polycheles* or any *Pentacheles?*" in reply to which I wish to add the following list:—

Willemoesia leptodactyla,	male and female.
Pentacheles lævis . .	female.
—— *Suhmi*	male.
—— *obscurus* . . .	female.
—— *auriculatus* . .	female.
—— *gracilis* . . .	female.
—— *enthrix* . . .	female.
Polycheles baccatus. .	male and female.
—— *Helleri* . . .	male and female.
—— *crucifer* . . .	male.

It will thus be seen that I have males and females of each genus.

I would, however, add that for some time I was hesitating where several species of *Pentacheles* should be placed, as there is a regular gradation from the imperfect to the perfect chelate character of the fifth pereiopod; but as I found *Polycheles*, both male and female, with the simple non-chelate foot, at present it appears to me that there is no arrangement so constant as that which I propose.

The next question the Rev. A. M. Norman asks is, "If so, will he let us know how these sexes are distinguished?"

When I read this I began to think that my reverend friend was poking fun at me. Does he really mean to insinuate that he thought I was not acquainted with what every fish-wife knows—the features distinctive between a male and female crustacean? Reading a little further, I find that the Rev. A. M. Norman had before him two specimens dredged during the 'Porcupine' expedition in 1870 (eight years ago), off the Spanish coast, which, he says, he considers to be "male and female of *Polycheles typhlops*, Heller; but the one is, according to Bate, a member of another genus (*Pentacheles*) differing from *Polycheles* in having the last pereiopods chelate, a deeper notch on each side of the front of the carapace, and slight diversity in the lateral and dorsal spiny adornments of the carapace. These are the only two specimens I have seen; my conclusion that their difference is sexual *may* be wrong. Can Mr. Bate *prove* it to be so?"* I have little doubt that I can and will, if he will intrust me with the specimens.

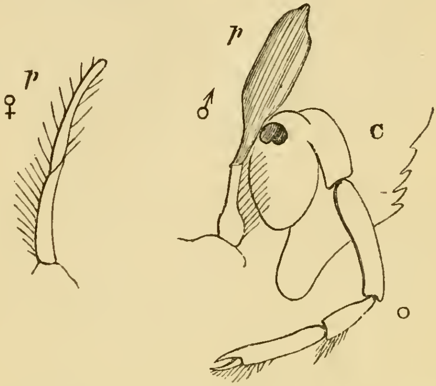
But why has not the Rev. A. M. Norman determined for himself their sexual relation to each other (he has, it appears, already had them eight years in his possession)? or is he really in earnest when he says, "Will he let us know how these sexes are distinguished?" Is this the reason why the Rev. A. M. Norman only *considers* them male and female, and yet criticizes the classification of others, while, in a note, he takes credit for having paired the British *Hyperiæ* and *Lestrigoni*? May I ask if he has done this also without observation of the sexual features? If so, all his arrangements can only be a more or less successful set of guesses.

As the *Willemoesia* group consists of animals that have not generally been met with, I would merely remark (and this may be of some assistance to the Rev. A. M. Norman in determining the relation that his two specimens bear to one another) that the organs of generation are generally very conspicuous, and situated as they universally are in macrurous Crustacea; but there is one feature that accompanies each sex that may be depended upon and be of material assistance in broken or injured specimens.

The first pair of pleopoda in the female has a tolerably long basal joint, with the terminal branch single and reduced to a feeble condition; while in the male the basal joint is short, and the terminal one long, stiff, and, shaped somewhat like a marrow-spoon, it lies with the concave surface next the pereion, and is evidently adapted, and I have no doubt is used, for the purpose of supporting the membranous penis during

* The italics are the Rev. A. M. Norman's.

the period of coition, and that it assists by compressing the male organ against the vulva of the female. I am inclined to think, from the variation of this organ in other families, that there may be a tendency to vary in size the nearer or the more distant may be the rutting-season. It varies somewhat in form with the species.



Willemoesia leptodactyla. C, posterior extremity of carapace; o, fifth pereiopod, with the orifice of the male organ in the basal joint; *p*, first pleopod.

The second set of questions that the Rev. A. M. Norman proposes relate to the eyes. "Eyes," he says, "are things to see with." True; but he must admit that they are not always available for this purpose. Then the Rev. A. M. Norman says, "Has *Polycheles* such organs?" Most decidedly it has; and I gave a distinct figure of one in the October number of the 'Annals.' But why did not the Rev. A. M. Norman examine the specimens in his possession? he would not then have had to write, "it were to be wished that Mr. Bate had lettered the figures of the plate to have made them more clear." Had I thought there would have been any difficulty in understanding them I would; but I felt that I was writing for advanced carcinologists, and therefore thought that the references would be unnecessary *.

Most certainly the eye I described is not on "the base of the peduncle of the inner antennæ," which, from its situation, cannot be the homologue of the true eye. That which I describe as being the eye is homologically the same as that found in *Astacus*, *Cancer*, &c.

* I see that, in the plate alluded to, fig. 1° has no reference; it is the fifth pereiopod of *Pentacheles gracilis*.

There was no "round black spot" on the base of the peduncle of the inner antennæ in any of the specimens that came within my observation; but there is a depression that may correspond with it, and is probably that which Heller noticed, but it is caused by the olfactory tubercle of the second or outer antennæ being impacted strongly against the inner. In the basal joint of the inner antennæ I have dissected out an osseous auditory apparatus, which is sufficient itself to determine that this same position cannot be occupied by an organ of sight.

The third set of questions evidently shows that my paper was read for the sake of criticism. I never said or thought that *Polycheles* was related in any way to *Alpheus*. I merely paralleled the development of the eyes in the two genera and the probable similitude of adult existence; and the Rev. A. M. Norman further adds, with a note of admiration to give it the more weight, "that the embryos of both have 'large and distinctly pedunculated eyes,' a character which, I take it, is not very rare among the embryos of the Macrurous Crustacea!" My remarks were in relation to adult forms with "depauperized organs of vision;" and therefore the Rev. A. M. Norman's remarks do not bear on the subject unless he knows the embryonic form of *Astacus? zaleucus* (Willemoes-Suhm), *Nephropsis Stewarti* (Wood-Mason), and the blind prawns of the North-American caverns.

With regard to the fourth set of questions, which relate to *Eryon*, I offer no opinion, but hope to be able, at no very distant date, to avail myself of the best opportunities at my command; in the meantime I cannot help remarking that all the notes on which the Rev. A. M. Norman lays so much stress are but negative in character.

However, I am much obliged for having my attention directed to points which I hope will enable the Rev. A. M. Norman to determine the sexual character of his own specimens of this group; and I can only add that I should have done it with more pleasure had the Rev. A. M. Norman's paper been written less in the style of a categorical examination.

Lestrigonus.

With regard to the notes relating to *Lestrigonus* the rev. gentleman has gone out of his way, and shows the character of his criticisms. He says, "There is another case, however, in which Mr. Bate persists against proof in maintaining a genus founded on mere sexual characters . . . . .; but all other carcinologists are, I believe, agreed that *Lestrigonus* is simply the male of *Hyperia*; and I have myself paired the British species."

If the Rev. A. M. Norman will turn to the 'Catalogue of Amphipoda' as far back as 1862, as well as to the 'History of the British Sessile-eyed Crustacea,' he will find that the relationship of *Lestrigonus* to *Hyperia* is distinctly mentioned; and in the latter appears the following passage:—

"In the same work ('Catalogue of Amphipoda') Mr. S. Bate has also suggested that the species of the present genus are but females of those of *Lestrigonus*. He arrived at this conclusion after examining a considerable number of species of both genera, finding it difficult, if not impossible, to assert (with reference to the structure of the antennæ) where one genus commences and the other ends. Recently, through the kindness of Mr. Edward, of Banff, we have had the opportunity of examining many fresh specimens both of *Lestrigonus* and *Hyperia* from the same locality; and we found that all the adult *Hyperiæ* of which the sex could be detected were females, but that none of the *Lestrigoni* were of that sex."

I feel somewhat ashamed to quote so long a passage out of that work for the purpose of replying to such small criticism, and to show that the Rev. A. M. Norman had no right to say that I "persist against proof," when he must have known that he himself took the inspiration of which he boasts from the writings of others, even if he has himself "paired the British species described by Bate and Westwood." See Brit.-Assoc. Report, 1868, p. 286, for the way he has done this.

"*Hyperia galba* (Montagu), Bate & Westw. Brit. Sessile-eyed Crust. vol. ii. p. 12, the female, = *Lestrigonus Kinahani*, Bate & Westw. *l. c.* p. 8, the male, =? *Lestrigonus exulans*, *l. c.* p. 5, the young male, =? *Hyperia medusarum*, Bate, Cat. Amph. Crust. Brit. Mus. p. 295, pl. xlix. fig. 1, the young female (but not *Metœcus medusarum*, Kröyer). In *Aurelia*, open sea, twenty-five miles N. by W. of Unst.

"I believe that the above four so-called species are the different sexes and periods of growth of one. The specific points will be found in the structure of the gnathopods (as accurately described by Bate & Westw. under *Lestrigonus exulans*) and of the uropods, which have the rami of all three pairs wide in the middle, but narrowed at the base and mucronate at the terminations; the inner margins of the rami of the first pair, and the inner margin of the outer ramus, and both margins of the inner ramus of the last two pairs are elegantly serrated."

To *Lestrigonus exulans* and *Hyperia medusarum* he prefixes a ?, to show that he felt doubtful of his facts; and in writing he says, "*I believe* that the above four so-called species are the different sexes and periods of growth of one." I therefore maintain that, whether they be all of one species or not, the Rev. A. M. Norman has done nothing to prove they are or are not *sexually* distinct. It is, however, too small a subject to pursue further. I feel assured, as was stated in the 'History of the British Sessile-eyed Crustacea,' that the *Lestrigoni* are the males of *Hyperiæ*; but I also think that it is desirable not to sink the name of the male until a new work of reference takes the place of those at present in use, wherein it is known as *Lestrigonus**.

The specimen from which I described *Diastylis bimarginatus* was a very poor one, and much broken before it reached me; but certainly it is not *Diastylis spinosa* of Norman, or his name and description are singularly infelicitous.

BIBLIOGRAPHICAL NOTICES.

The Geology of Sussex; or the Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex. By the late Frederick Dixon, Esq., F.G.S. New Edition. Revised and augmented by Professor T. Rupert Jones, F.R.S., F.G.S. 4to. Pp. xxiv and 469. With a Geological Map, 64 plates, and numerous woodcuts. W. J. Smith: Brighton, 1878.

The first edition of this splendid work, so well known to geologists, was published in 1850, when Mr. Dixon's posthumous writings were completed and supplemented by his friends Professors Owen, Bell, and Forbes, Messrs. Sowerby, Lonsdale, and others, and edited by Owen himself. The illustrations and descriptions of the Tertiary and Cretaceous fossils then supplied to geologists rendered this a classic English work. Since Mr. Dixon's decease further researches among the highly fossiliferous strata of Bracklesham and the neighbouring districts have enabled Prestwich, Edwards, Fisher, and others to compare and classify this portion of the Eocene formations, with great exactitude, one with another and with similar strata in France and elsewhere. So also with regard to more recent deposits along the Sussex sea-board, R. Godwin-Austen, J. Prestwich, and A. Bell have elucidated, far more clearly than previously, the extent, relations, and age of the "old raised beach," the "boulder-bed," the "mud-deposit," and other now well-known Post-tertiary formations, which had already received much attention from Mantell, Lyell, Dixon, and earlier observers.

* When I wrote to the 'Annals' I was under the impression that *Lestrigonus* had priority of date to *Hyperia*; but I find that the latter is one year in advance. Hence I wrote as I did, rather than *Hyperia* (*Lestrigonus*) *spinidorsalis*. I thank the Rev. A. M. Norman for giving me the opportunity of correcting it.

With regard to the Chalk itself, the groundwork of the country, more definite and trustworthy views as to its origin, extent, and subdivisions have been added to the shrewd but somewhat vague notions of earlier geologists, by a host of English and continental naturalists, within the last twenty years; and the Chalk fossils, so well depicted in the fine plates of Dixon's and Mantell's works on Sussex, have been more definitely determined, in very many instances, by later palæontologists at home and abroad.

By invoking the aid of his colleagues, collaborateurs, and friends, geological and palæontological, in the reproduction of notes and memoirs, published in various periodicals, elucidative of some of the matters within the range of Dixon's great work, in the revision and correction of determinations of the manifold fossil forms treated of, and, lastly, in the contribution of descriptions of newly observed organic remains, the Editor of the present volume has rearranged and, indeed, reconstructed this now comprehensive "Geology of Sussex." To enumerate those who have so willingly and energetically coöperated with Prof. Rupert Jones in thus restoring, as it were, a noble literary and scientific monument to the late Frederick Dixon, one of the best geologists of Sussex, would be to mention a very large proportion of both the veteran and the rising geologists of the day. Antiquaries, too, of such high standing as C. Roach Smith and John Evans, with others, have given assistance in revising notes on those interesting antiquities of Sussex which Dixon described, *con amore*, in his work; and one of the younger archæologists (Mr. E. H. Willett) has given valuable contributions on like matters.

The 1st, 2nd, 3rd, 6th, and 8th chapters of the book, treating of the Post-tertiary, Tertiary, Cretaceous, and Wealden formations, are new—either written by the Editor, or composed of important papers, reprinted or contributed for the occasion, on the geology of Sussex localities. Chapters 4, 5, and 7 have been revised throughout and much augmented with similar matter.

In Part II. the description of the fossils has been carefully revised throughout. The Plant-remains of Sussex, both Tertiary and Cretaceous, have been described most satisfactorily, in comprehensive memoirs, by Mr. Carruthers. The Ventriculites have been clearly demonstrated by Mr. W. J. Sollas. The Foraminifera have been treated anew by Mr. H. B. Brady and the Editor; and the latter adds a list of those of the English Chalk and Chalk-marl. The Crustacea have been revised and added to by Dr. H. Woodward, with the concurrence of Prof. Bell, F.R.S. Sir P. Grey-Egerton and Mr. E. T. Newton have fully revised the fossil Fishes; and the latter has supplied a perfect list of those of the English Chalk. The descriptions and notes on the numerous and interesting fossil Reptiles, having received Prof. Owen's best attention, are, again, brought up to the requirements of the day.

Some points of special interest to the people of Sussex, and dwelt on more or less particularly in this volume, are:—1, the physical geography of this county and the neighbouring counties, as being distinctly referable to the geological structure; 2, the investigations into the nature and history of the formations constituting the promontory of Selsey; 3, the origin and range of the old beach and sea-line, now elevated many feet above high tide; 4, the ancient British gold coinage; 5, the hill-forts, especially Cisbury and its prehistoric manufactory of flint instruments; 6, the discovery of a palæolithic flint weapon in the "coomb-rock" near Brighton; 7, the Tertiary beds of Newhaven and of the Brighton neighbourhood; 8, the series of strata recognized in the deep well at the Warren Farm, so boldly conceived by Mr. Willett, perseveringly continued and successfully finished; 9, the structure of the Wealden area, the succession and nature of its strata, the origin and formation of its wonderfully symmetrical river-valleys; 10, the history and results of the undertaking known as the Subwealden Exploration, suggested by Mr. H. Willett for the determination of the deep-seated geological structure of the south-east of England, well told by Mr. Topley and illustrated by admirable sections; 11, the explanation of several well-known features at Eastbourne, Pevensey, Bexhill, and Hastings; and, 12, the valuable record (communicated by Mr. T. Ross) of the changes that have brought about the silting-up of the ancient harbour of Hastings. The Editor's explanation of the origin of flint nodules, as due to the *pseudomorphosis* of chalk by silica, and his insisting on the theory that the Wealden valleys are due to nearly symmetrical fissures and other disturbances of the strata—a theory that found favour with Martin and Hopkins, was contemned by others, and again supported by later observers (Barrois, &c.)—are also new to the work.

A judicious selection from the handsome plates published years ago in Mantell's 'Fossils of the South Downs,' and a careful explanation of the figures, form a portion of this handsome and well illustrated volume. With these figures of the most important typical Cretaceous fossils of Sussex, added to those given in the other twenty-four plates of Chalk fossils originally drawn for Mr. Dixon, the student has a comprehensive repertory of the organic remains of the South-English Chalk and associated beds. Fifteen plates of Tertiary fossils from Bracklesham (Bagshot series) and Bognor (London Clay), numerous woodcuts, some whole pages of sections, a vignette etching of the old Block-house at Brighton, and a beautiful map of the South-east of England, with Sussex geologically coloured, adorn this elegantly printed work. A carefully constructed index and abundant cross-references enable the reader to follow any subject throughout the several chapters, geographical, geological, or palæontological, in which its notice or fuller treatment may occur. The multitudinous species of organic remains enumerated in the book can be readily studied by referring to the numerous lists of specific names and their authorities; and amongst these catalogues, (1) those of the shells from the "Mud-deposit" of Selsey, (2) those of the shells from Bracklesham and from Bognor,

(3) that of the Chalk Foraminifera, and (4) that of the Fishes of the Chalk are especially noticeable.

Having thus indicated the chief features of the new edition of Dixon's 'Geology of Sussex,' we are sure that it will command the attention it so well deserves, and that the people of Sussex will be proud of so good a work, written and published amongst themselves. And though brought out for the honour of Brighton and the county (we are assured in the Preface) without expectation of adequate remuneration, by the liberal and patriotic publisher, we trust that educated men of all stages of society, not only in Sussex, but of England throughout, will support so praiseworthy an undertaking. Nor are we without expectation that, not only British, but Continental, Colonial, and American geologists will fully appreciate and, if possible, possess themselves of so useful and well-illustrated an epitome of the Cretaceous and Tertiary Geology of the South-east of England.

A Catalogue of Australian Fossils (including Tasmania and the Island of Timor) stratigraphically and zoologically arranged. By Robert Etheridge, Jun., F.G.S. &c. Edited for the Syndics of the University Press. 8vo. Pp. x and 232. Cambridge, 1878.

The production of this model Catalogue of Fossils is highly creditable to the author and to the Syndics of the Cambridge Press. It is a work of love by a conscientious and enthusiastic geologist, and a very useful and elaborate volume printed liberally by the University at considerable expense.

Australia, with its vast continental area, vies with the longer-known continents in geological interest, and, like other lands, can be fully adapted to the requirements of civilization only by a proper knowledge of its geological structure on the part of its occupiers. How much has been done to acquire and impart this valuable knowledge by the zeal, energy, and self-sacrificing labours of explorers, surveyors, and amateurs in the Australian Colonies is clear to the reader of the Preface, and the student of the Text, Appendix, and Bibliographic List, in Mr. Etheridge's categorical epitome of Australian and Tasmanian palæontology. We have in this well-arranged book a full list of the fossil organic remains hitherto discovered in these regions, arranged zoologically under the several great stratal series. Thus:—1. "Lower Palæozoic, Silurian" (24 pages); 2. "Middle and Upper Palæozoic, Devonian and Carboniferous" (63 pages); 3. "Mesozoic" (24 pages); 4. "Tertiary" (53 pages); 5. "Post-tertiary" (20 pages); 6. "*Incertæ sedis*," those "species to which either no definite geological horizon, locality, or systematic position can be assigned" (2 pages); and 7 (in an appendix of 6 pages). Those species and references published or met with whilst the sheets were in press. A closely-printed list of books and papers consulted by the author fills 22 pages; and a careful index of the genera (6 pages) completes this excellent Catalogue.

Not only does this book, as a list of genera and species, meet the requirements of the geologist collecting, arranging, and tabulating the fossils he obtains, but the perfect and masterly manner in which the authorities and references are enumerated with each genus and species, not carelessly or scrimpingly, but liberally as to titles, pages, and figures (rivalling H. G. Bronn's splendid 'Index Palæontologicus,' and Morris's 'Catalogue of British Fossils'), is evident on every page, and gives a particular value to this laborious compilation. The natural orders and families are carefully mentioned; and the *best* figures and descriptions, too, are specially indicated; and there are extremely few references which the author has not himself consulted.

The cordial recognition of every aid given to Mr. Etheridge in the furtherance of this most valuable work is a pleasant feature; and the sympathetic and respectful mention of the labours of the pioneers and promoters of Australian geology is most honourable to our author, who has himself been an active labourer in that most interesting and useful field of science.

MISCELLANEOUS.

Note on the Occurrence of the Genus Lymnæa *in Australia.* By Alfred Brown.

In a sketch of the "Geographical Relations of the New-Zealand Fauna," in the 'Annals' for January and February 1874, Captain F. W. Hutton remarks that whilst the genus *Lymnæa* extends from North America and Europe to India, China, and Java, it is not found in Australia, reappearing, however, in New Zealand. Bearing this statement in mind I was surprised, on examining a parcel of freshwater shells brought home from Queensland by my brother, to find certainly two, probably three, species of *Lymnæa* mixed up with the characteristic *Physæ* and *Melaniæ* of Queensland waters.

One of the species is from Huntly Creek, Peak Downs; the other (or two others) are from the Isaac and Burnett rivers.

That these habitats are strictly correct I have not the slightest doubt, the specimens having been collected *en route* from Northern Queensland to Sydney, whence the steamer brought the collector direct home; and the shells reached me packed in their native mud. Further evidence of locality was found on breaking up a decayed specimen, when a small example of a *Physa* common in the Isaac river was found imbedded between the whorls.

Whilst on the subject of Captain Hutton's paper, I may state that *Nautilus pompilius*, which he excludes from the Australian fauna, is occasionally, but very rarely, found thrown up on the beach in the vicinity of Port Bowen, from which locality I lately received a fresh example. Captain Hutton refers the "pipi" of the New-Zealand natives to *Chione Stutchburyi*, Gray (Wood's Cat. Suppl.

Venus, f. 4). I have always understood that Dr. Gray's reference of the "pipi" (on the authority of Sinclair and Dieffenbach) to *Mesodesma Chemnitzii*, Deshayes (Wood's Cat. *Mactra*, f. 24), was the correct one.

20 Huntly Gardens, Glasgow,
Nov. 15, 1878.

Note on the Number of Cervical Vertebræ in Dinornis robustus. By Prof. F. W. Hutton, of the Otago University.

Last July a magnificent skeleton of *Dinornis robustus*, found in the Shag valley, was presented to the Otago Museum by A. W. Bell, Esq. This skeleton is complete, with the exception of the cranium, first, second, third, and sixth cervical vertebræ, a few caudal vertebræ, two left ribs, and the metatarsal of the left hallux.

The cervical vertebræ are twenty-one in number (including the four that are missing), and the dorsal are six, or twenty-seven in all. The fifth is without any median hypapophysis. The neural spine becomes single on the nineteenth; the hypapophyses become single on the twentieth. The hypapophyses are furthest apart on the fifteenth. It thus appears that the number of vertebræ in the long-legged species of Moa was the same as in the short-legged, in which I have already shown (Ann. & Mag. Nat. Hist. 1878, 5th series, vol. i. p. 407) the number of cervical vertebræ to be twenty or twenty-one.

A remarkable peculiarity in this specimen is that the neural spine is single on the fourth and fifth cervicals. There are six ribs on each side, of which the third and fourth alone bear sternal ribs. There is no appearance of any floating sternal rib as in *D. elephantopus*. The proximal phalanx of the hallux is articulated to the ungual phalanx, but not to the metatarsal of the hallux, which is detached.

There is in the Museum collection the leg and foot of a specimen of *D. casuarinus*, in which the metatarsal of the hallux is preceded by another bone. This bone is thin, flat, and triangular in shape, it apex being distal and completely detached from the other metatarsals. Whether it is a continuation of the metatarsal, or whether it represents the calcaneum, I am uncertain.

On the Affinities of the Coleopterous Genus Hades, *Thomson* (Heteromera, Nilionidæ). By Charles O. Waterhouse.

I have just been referring to M. Thomson's monograph of the family Nilionidæ*; and seeing that the new genus *Hades* was founded on a Javan insect received from Dr. Horsfield, I at once looked at the Horsfield collection of Javan Coleoptera in this museum, and was glad to find two specimens which are undoubtedly

* 'Musée Scientifique,' 1860, p. 13.

identical with Thomson's *Hades tenebrosus*. A careful examination of this species convinces me that it is not correctly placed in the Nilionidæ. The form of the head, the distant anterior coxæ (which are described as transverse, but which are totally differently formed from those of *Nilio* and which would be much more accurately described as globular), the structure of the tarsi, &c. appear to me to be quite foreign to the Nilionidæ. There can be no doubt that *Hades* is very closely allied to *Crypsis*, which I described recently (Ent. Month. Mag. 1877, xiv. p. 73) and placed near *Chartopteryx* in the Cyphaleinæ; and I believe I am correct in placing both these insects in that subfamily. The tarsi in *Nilio* are filiform: that is to say, they are not flattened beneath; and they are sparsely pubescent. In *Hades* the tarsi are somewhat flattened beneath and are densely clothed with long soft pubescence; that of the posterior tarsi is divided longitudinally by a fine smooth line, as in *Hemicyclus* and some other Cyphaleinæ.

British Museum,
Oct. 28, 1878.

The Balæna (Macleayius) australiensis *of the Paris Museum, compared with the* Balæna biscayensis *of the University of Naples.* By M. F. Gasco.

It will be remembered that, on the 9th of February, 1877, there was captured in the harbour of Tarento a true whale, which, it would appear, is the first that has been seen in the Mediterranean; and that its complete skeleton is now in the cabinet of Comparative Anatomy of the University of Naples.

On the 3rd November, 1877, I had the honour to present to the Royal Academy of that city a first memoir, which has since been published. A careful examination of the osteological characters soon showed me that the whale of Tarento was identical with that captured in 1862 in Delaware Bay opposite Philadelphia, and upon which Mr. E. Cope published a very brief osteological report in the year 1865.

Both the Tarento whale and that of Philadelphia belong to the species *Balæna biscayensis*, Eschricht, which for several centuries was pursued with avidity, and, I was going to say, exterminated, throughout the temperate region of the North Atlantic, first by the Basques, and then successively by the Saintongeois, the Normans, the Dutch (who called it *Nordkaper*), the Danes, Norwegians, English, and Americans.

Being invited to take part in the seventh Congress of the French Association for the Advancement of Science, I hastened on my arrival in Paris to visit the superb Cetological collection which figures in the galleries of Comparative Anatomy, and especially the complete skeletons of *Balæna mysticetus*, *B. australis*, and *B. antipodum*, the last of which is still the sole individual of its species in European Museums.

In the laboratory of M. P. Gervais they are engaged in mounting the skeleton of another very interesting whale, sent from New Zealand by Mr. Hutton of Dunedin. Of this species there are only two skeletons in Europe:—one at the British Museum, which was in great part described by J. E. Gray; the other at the above-mentioned laboratory, and on which M. Gervais has lately published some notes with figures in his 'Journal de Zoologie.' I had scarcely seen this skeleton of *Macleayius* when I immediately recognized its great resemblance to that of *Balæna biscayensis* at Naples, although the two species cannot be united into one.

Measured in a straight line the [skull of] the *Macleayius* is 2·43 metres, and following the outer contour 2·76. In consequence of the great development of the intermaxillary bones, the maxillaries cannot come into contact with the bones of the nose, and the minimum distance between the maxillary and the occipital is reduced to 0·02 metre. Following the outer contour, the length of the intermaxillaries is 2·07 metres; their anterior extremities are separated by 0·10 metre.

In a straight line the length of the palatine is 0·49 metre. The frontal, in its median portion, is only 10·11 centims. in length; it presents no protuberance. The distance in a straight line between the two postorbital apophyses of the frontal is 1·63 metre, and following the outer contour 2·04 metres. The postorbital apophysis exceeds that of the temporal by 3 or 4 centims.; and their minimum distance is only 23 millims. The squamosal portion of the occipital is 0·65 metre long and 0·63 broad; it presents no median crest. Its greatest lateral depression, as in *B. biscayensis*, is 0·05 metre.

The zygomatic and glenoid apophyses of the temporal are less distinct than in *B. biscayensis*.

Following the outer contour of the mandible its length is 2·47 metres, and in a straight line 2·16; its maximum height at a distance of 20 centims. from the coronoid apophysis is 0·285 metre.

The right tympanic bulla has a maximum length of 12 centims.: its breadth, taken at the middle, is 8 centims. The contour of its lower surface affects the oval form less than that of *B. biscayensis* and *antipodum*. On the lower surface there is a well-marked and nearly median longitudinal depression, about 2 centims. broad. The two apophyses of the petrous portion are well developed.

The vertebræ of the cervical region are firmly united, but all very distinct laterally, except a small lower portion of the third, which for a distance of 7 centims. is confounded with the fourth on the left side. The width of the atlas is 48 centims.

There are thirteen dorsal and thirteen lumbar vertebræ. Upon the ninth dorsal the muscular or accessory apophysis is already very distinct. The transverse apophyses of the third and fourth lumbars are nearly perpendicular to the body of the vertebra. The spinal artery passes directly across the base of the transverse apophysis of the fifth caudal. The last rudiments of transverse apophyses are observed on the tenth and eleventh caudals. The last two caudals are nearly round, especially the penultimate, the diameter of which is 65 millims.

The ribs of the first pair have their sternal extremity much more widened than in *B. biscayensis*.

The scapula is a little thicker than in the latter species, and presents a very small rudiment of the coracoid apophysis. It is much wider than high; as in the *B. biscayensis* of Naples and Philadelphia, its width is 15 centims. more than its height.—*Comptes Rendus*, September 9, 1878, p. 410.

On Parthenogenesis in Bees. By M. A. Sanson.

In a recent note * M. J. Perez throws doubt upon the phenomenon of parthenogenesis in bees, taking his stand upon a certain interpretation of facts of heredity which he has observed. I am surprised to find him speaking of a fact as hypothetical which has been demonstrated experimentally a great many times, and the verification of which is a very easy matter. In 1868 (Comptes Rendus, tom. lxvii. p. 51) the Academy had before it a proof of this fact. I exhibited a comb containing only worker-cells filled with males or drones developed in those cells. M. Bastian and myself had obtained it at Wissembourg, by causing a female, the seminal receptacle of which was destitute of spermatozoids, to deposit her eggs in it. I also, at the same time, exhibited workers lodged in drone-cells, and produced from eggs laid by a fecundated female which had no other cells at her disposal. The purpose of our experiments had been to check the theory put forward by Landois with regard to the mode of development of the sexes. All bee-keepers who are *au courant* of science know that the old queens which become drone-mothers (*bourdonneuses*)—that is to say, which no longer lay any but drone-eggs—have exhausted their provision of spermatozoids. When their seminal receptacle is examined under the microscope, it contains only a perfectly transparent fluid. We know also that lowering the temperature of a young fecundated queen to such a degree as to kill the spermatozoids suffices to render her immediately a drone-mother. The young queens which have never coupled, and the workers which sometimes lay in hives which, having lost their queen by accident, are called *orphan-hives*, only deposit male eggs.

These are facts acquired for science. It is easy to show, moreover, that the interpretation of his observations given by M. Perez is not the correct one. In a hive, the queen of which, he says, was the daughter of an Italian of pure race and had been fecundated by a French male, he examined with scrupulous care 300 drones. He found the Italian characters in 151, those of hybrids of different degrees in 66, and the French characters in 83, "from which," he adds, "it evidently follows that the eggs of drones, like the eggs of females, receive the contact of the semen deposited by

* See Ann. & Mag. Nat. Hist. November, 1878, p. 428.

the male in the organs of the queen, and that Dzierzon's theory, created to explain an ill-ascertained fact, becomes useless if this fact is disproved."

One is by no means struck with the evidence of any such conclusion, being in a position to adduce the intervention of the known laws of heredity. With an Italian queen of incontestably pure race the drones have exclusively the Italian characters, although she may have coupled with a male of a different race. The workers alone are hybrids. The author has evidently had before him a case of reversion. He had in his hive, as he tells us, true Italian workers, others French, and others, again, presenting a mixture in diverse proportions of the characters of the two races. This is in conformity with the usual results of crossing. The queen of this hive was no doubt an Italian of the same sort as the workers of his first category. The atavism of a black male which intervened in a preceding generation has manifested itself in different degrees. The same fact is often presented in German and French hives into which Italian queens have been introduced. I remember having myself made a similar observation in the hive of M. Bastian at Wissembourg, ascertaining the hybrid origin of the queen, the external characters, however, of which were purely Italian.

At any rate, it is not in conformity with the present condition of science to represent the parthenogenesis of bees as a hypothesis accepted solely because of its utility in explaining a fact which is incontestable; for its reality has long since been established by experiment.—*Comptes Rendus*, October 28, 1878, p. 659.

The Development of Ligula. By M. Duchamp.

On the 24th December last M. Duchamp presented a note to the Academy of Sciences, in which he showed, by experiments made on the common pigeon, that for the development of *Ligula monogramma*, Crepl., into a perfect Cestoid it is not necessary that the worm should be introduced into the body of any particular species of animal, but that it can be effected in the digestive canal of any warm-blooded vertebrate.

Continuing his investigations, M. Duchamp endeavoured to rear the *Ligulæ* in artificial media, such as meat-soup, &c., kept at a temperature of about 38° C. (100° F.), but without success. He then introduced a certain number of *Ligulæ*, derived from two tench, into the peritoneal cavity of a dog. No symptoms of peritonitis were produced; and the dog having been killed four days after the operation, the *Ligulæ* were found living with their reproductive organs developed and in full functional activity, the testes being inflated with spermatic cells, and the ova already formed. One of the *Ligulæ* thus transported from the tench to the dog had been divided into two parts; and each fragment was developed in the same way as the entire individuals.—*Ann. des Sci. Nat., Zool.* sér. 6, tome vii., August 1878.

INDEX TO VOL. II.

END OF THE SECOND VOLUME.

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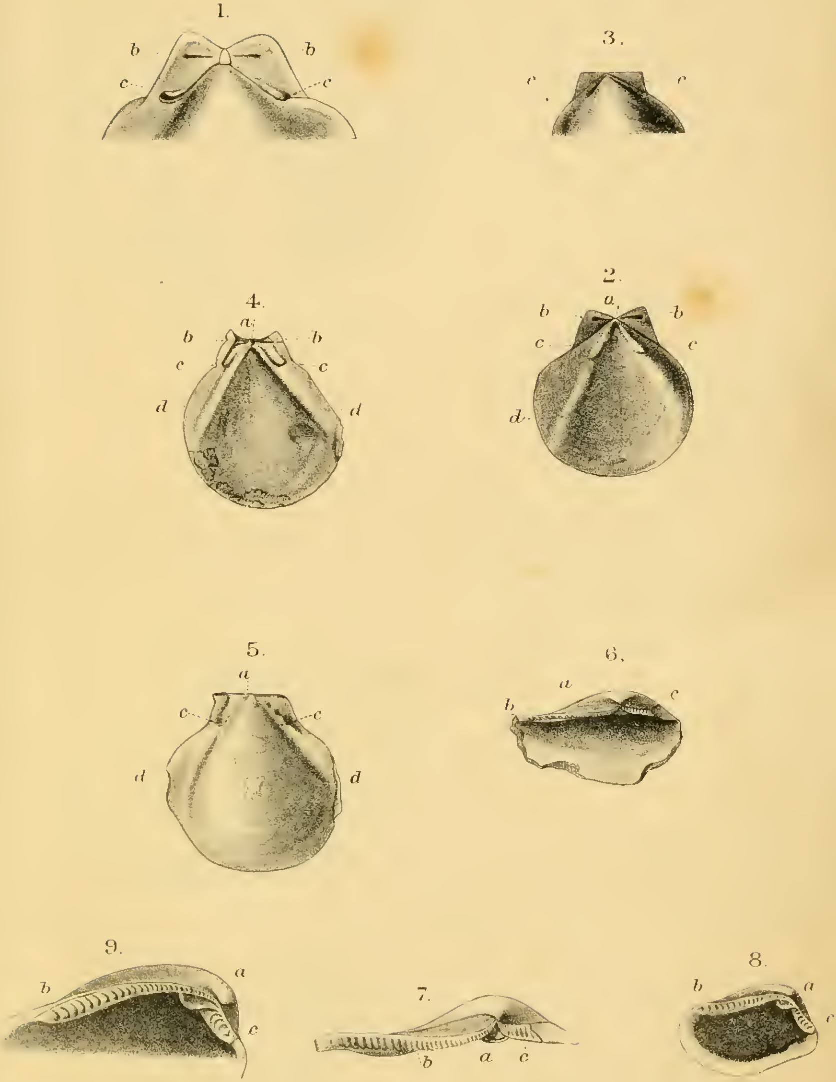

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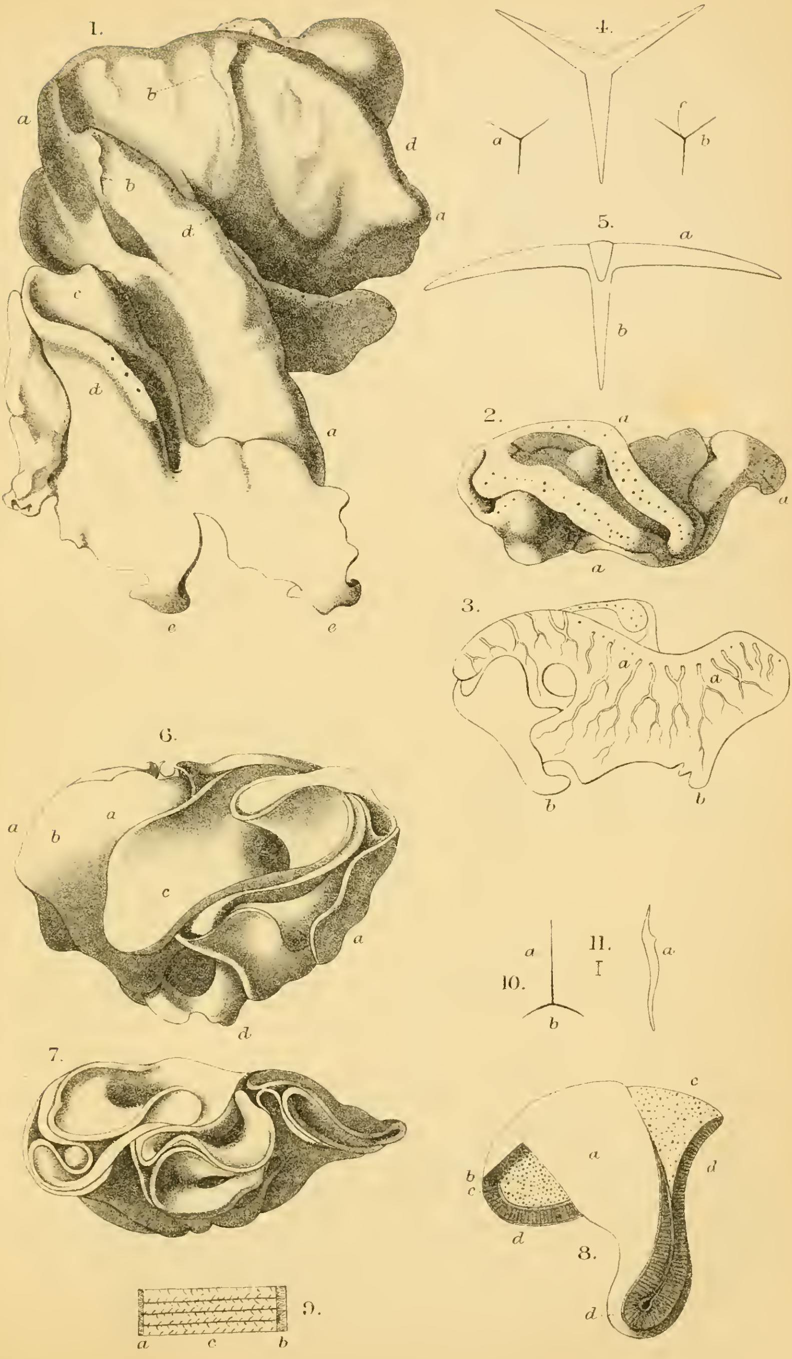

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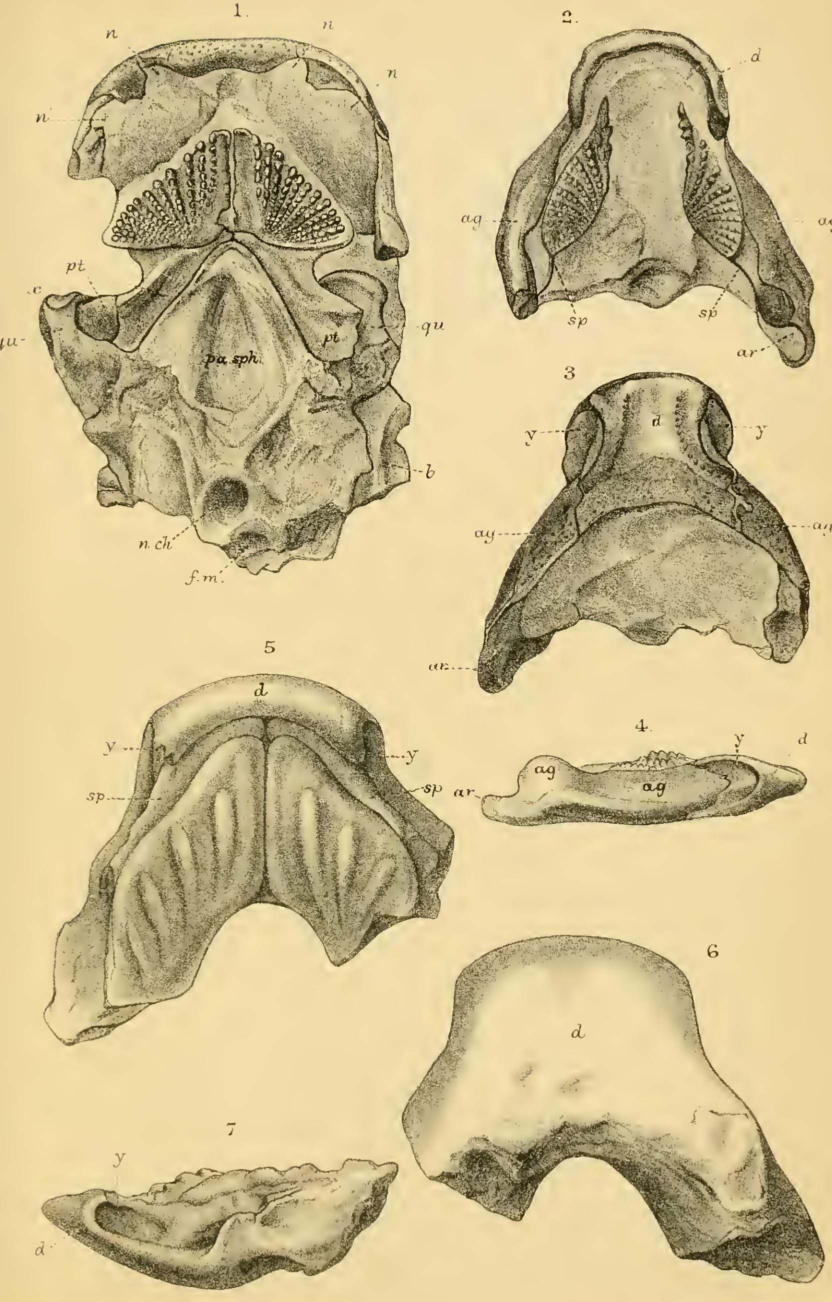

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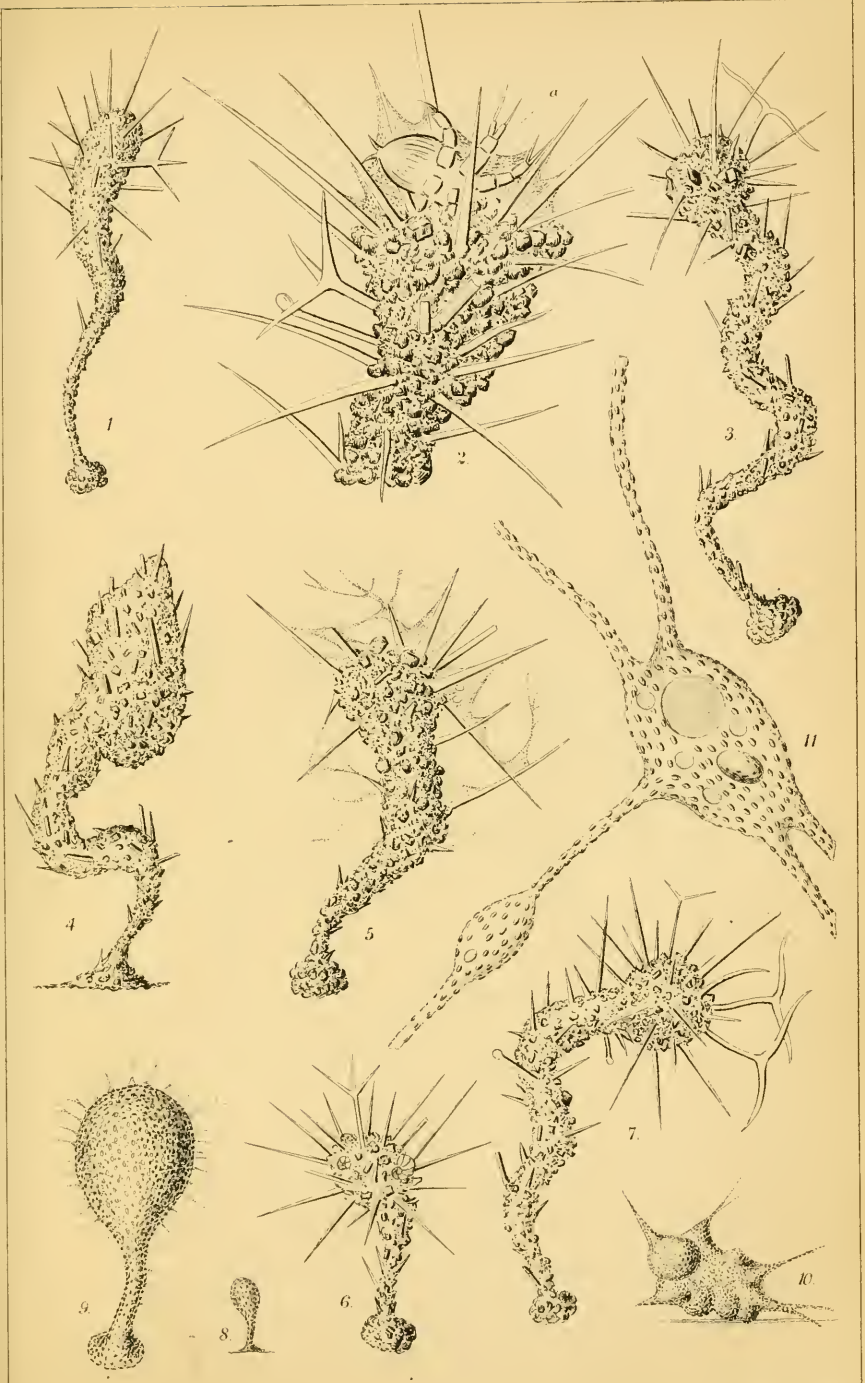

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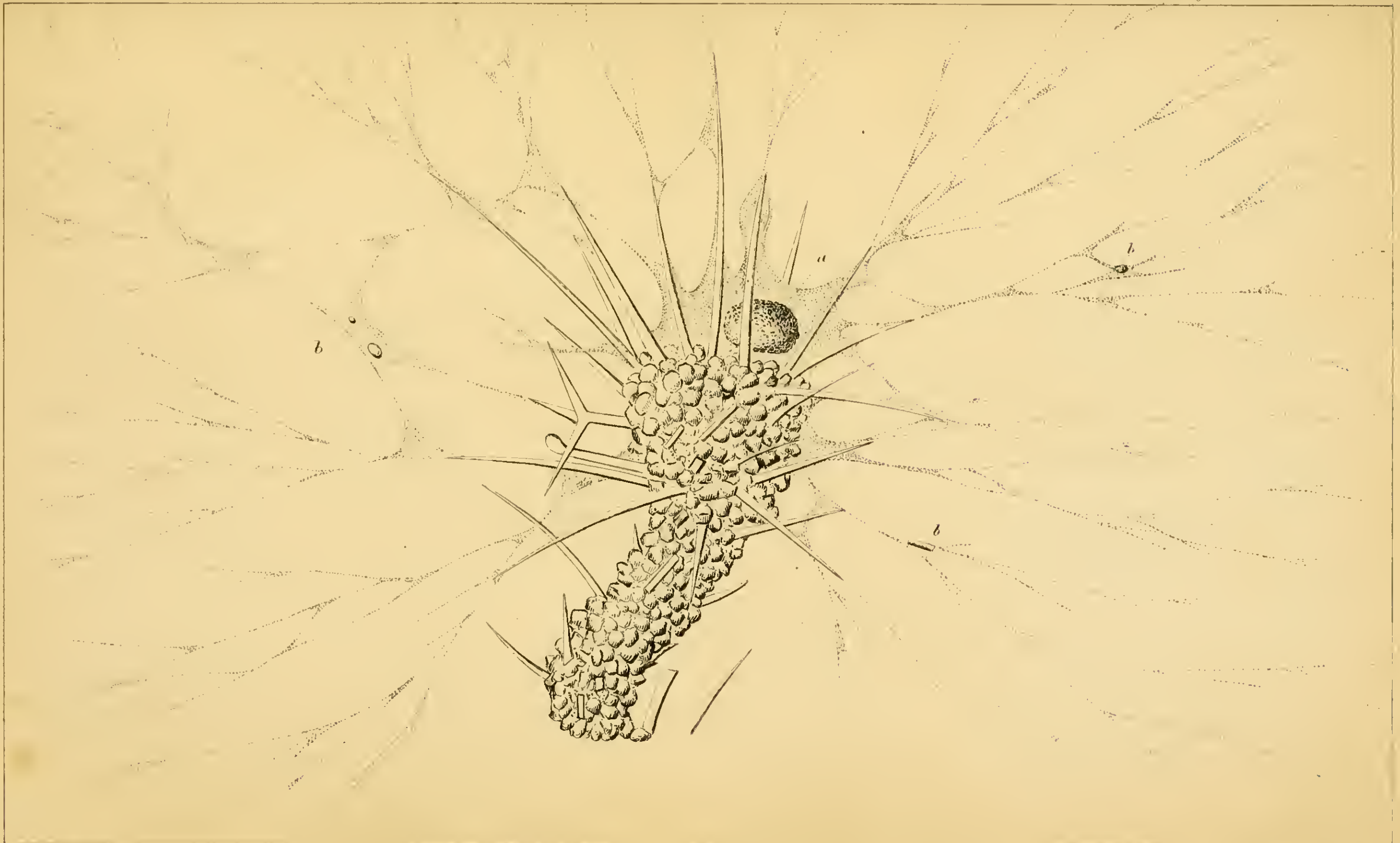
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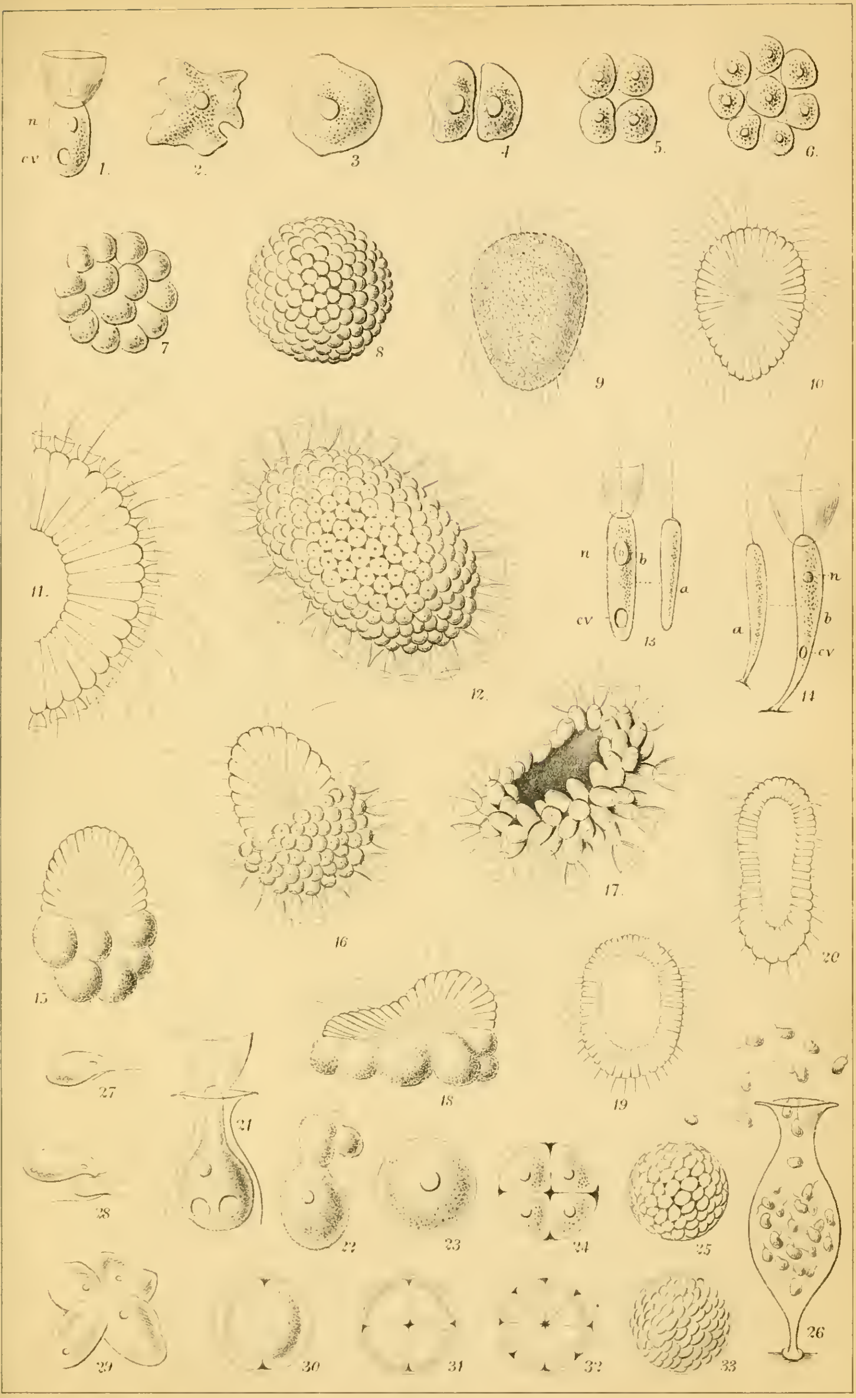

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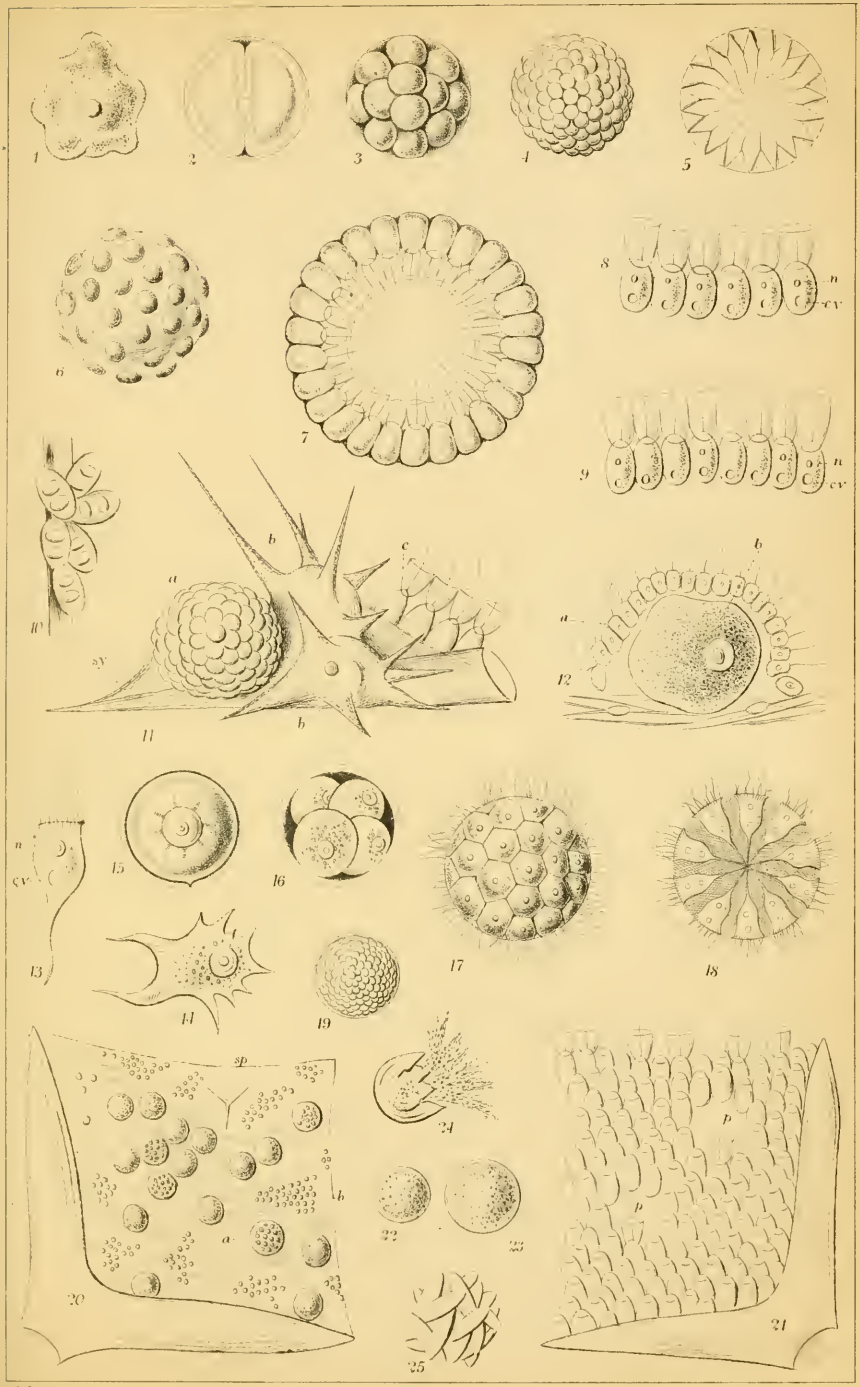

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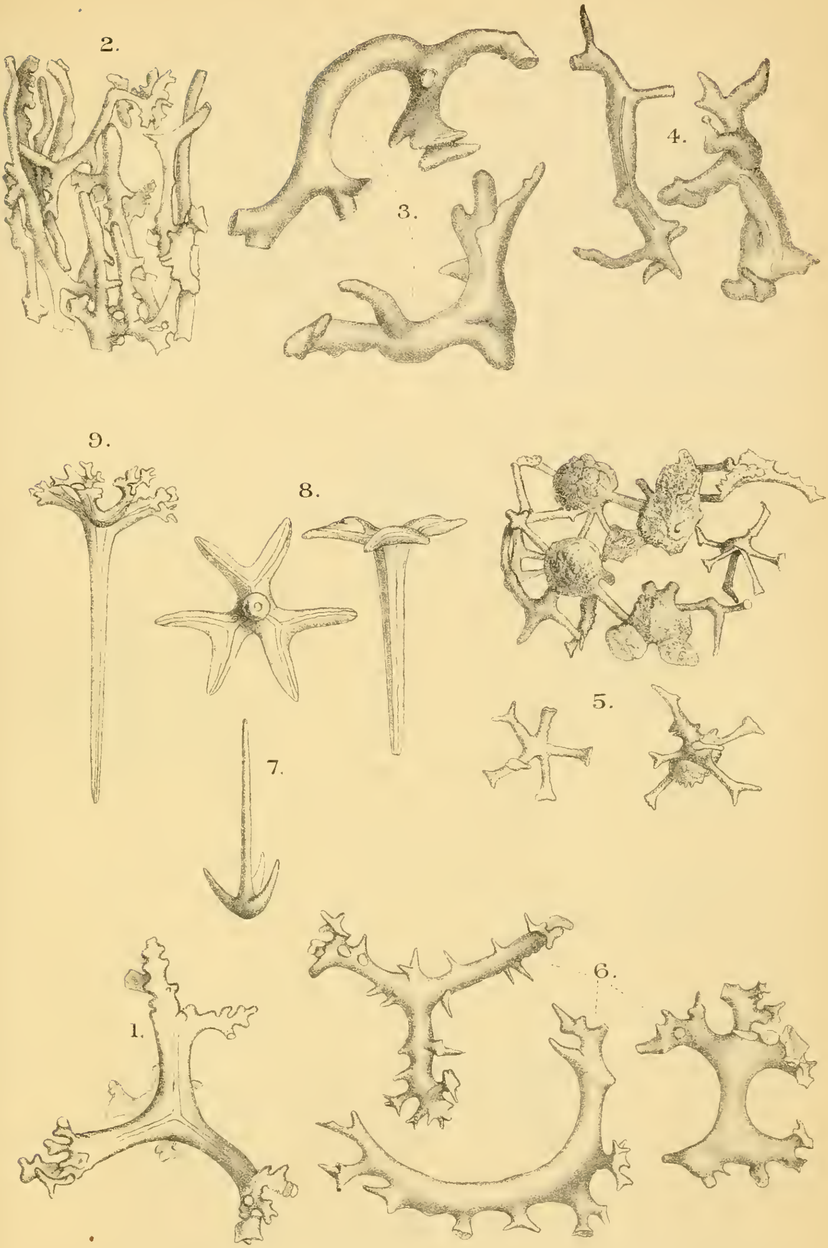

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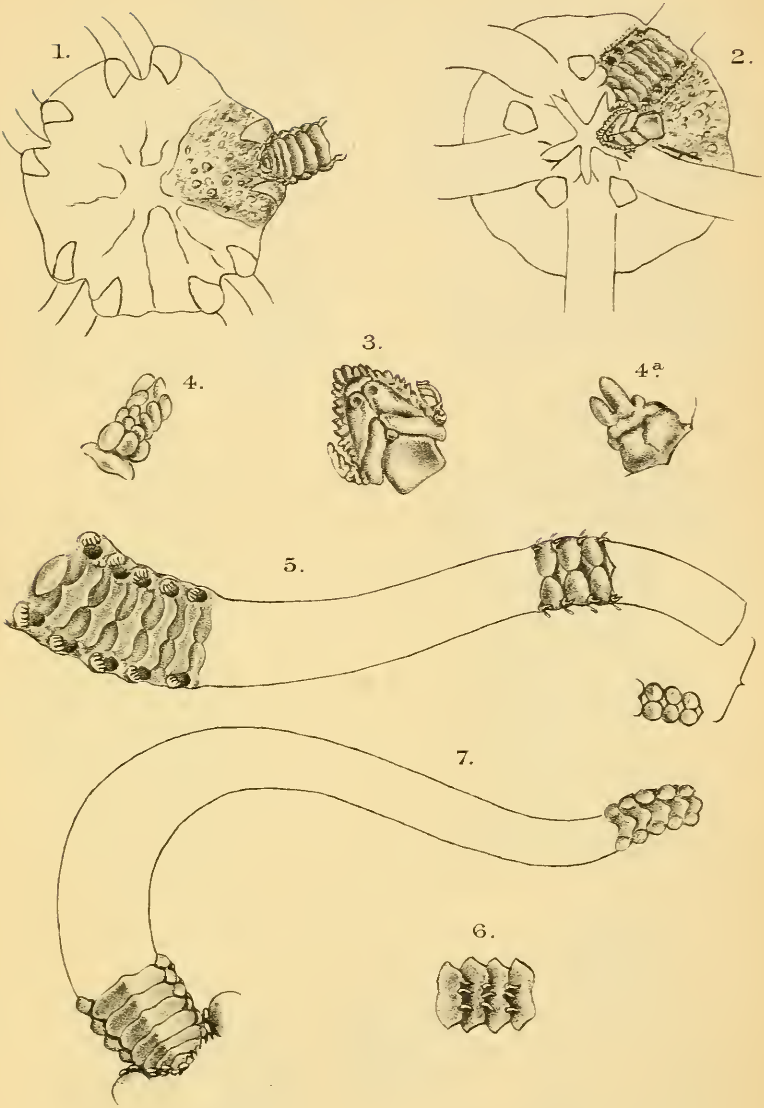

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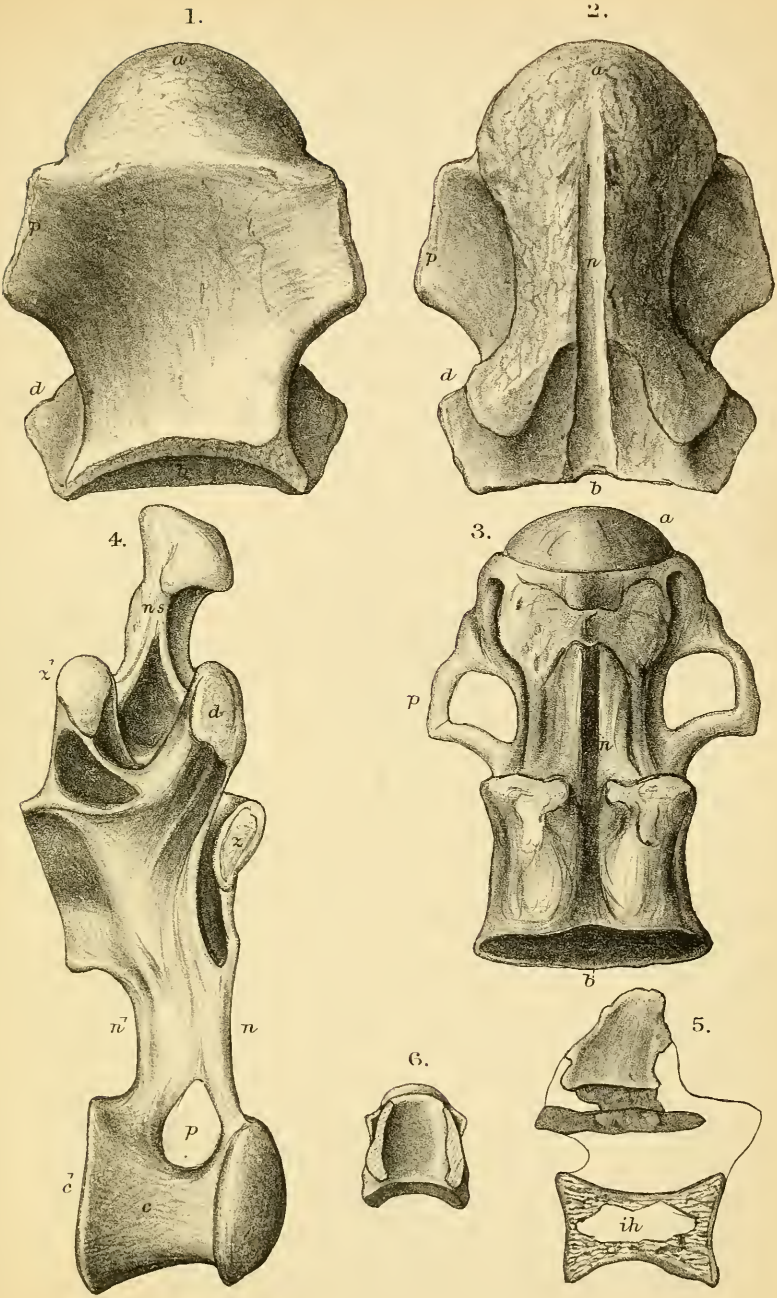

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Fig's 1–3. CHONDROSTEOSAURUS.

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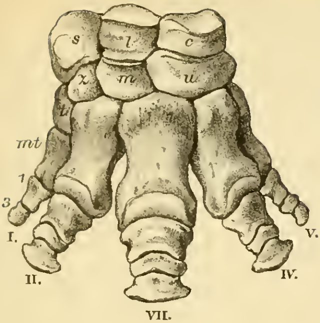

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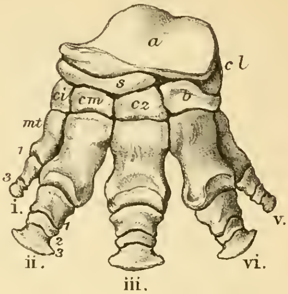

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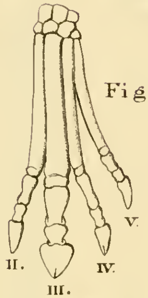

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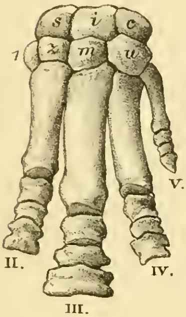

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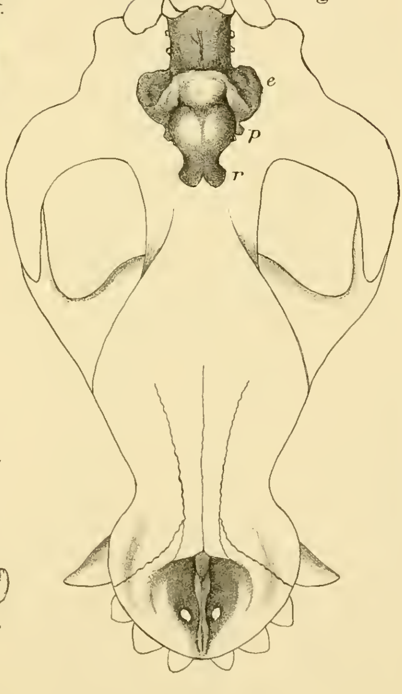

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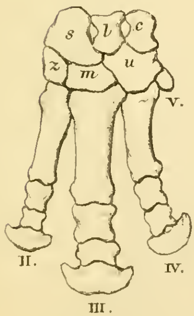

Fig. 8.

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Fig's. 1. 2. 3. CORYPHODON.

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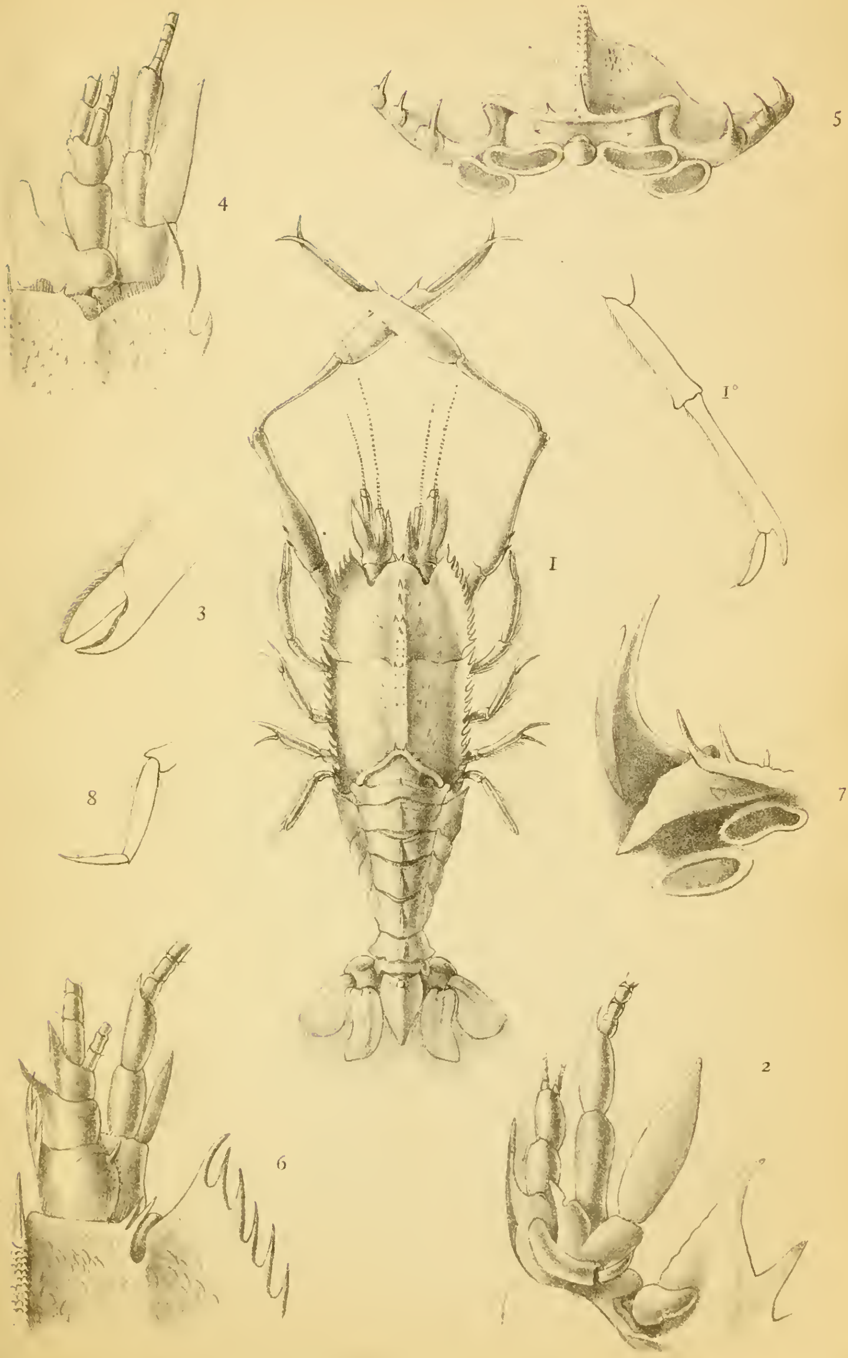
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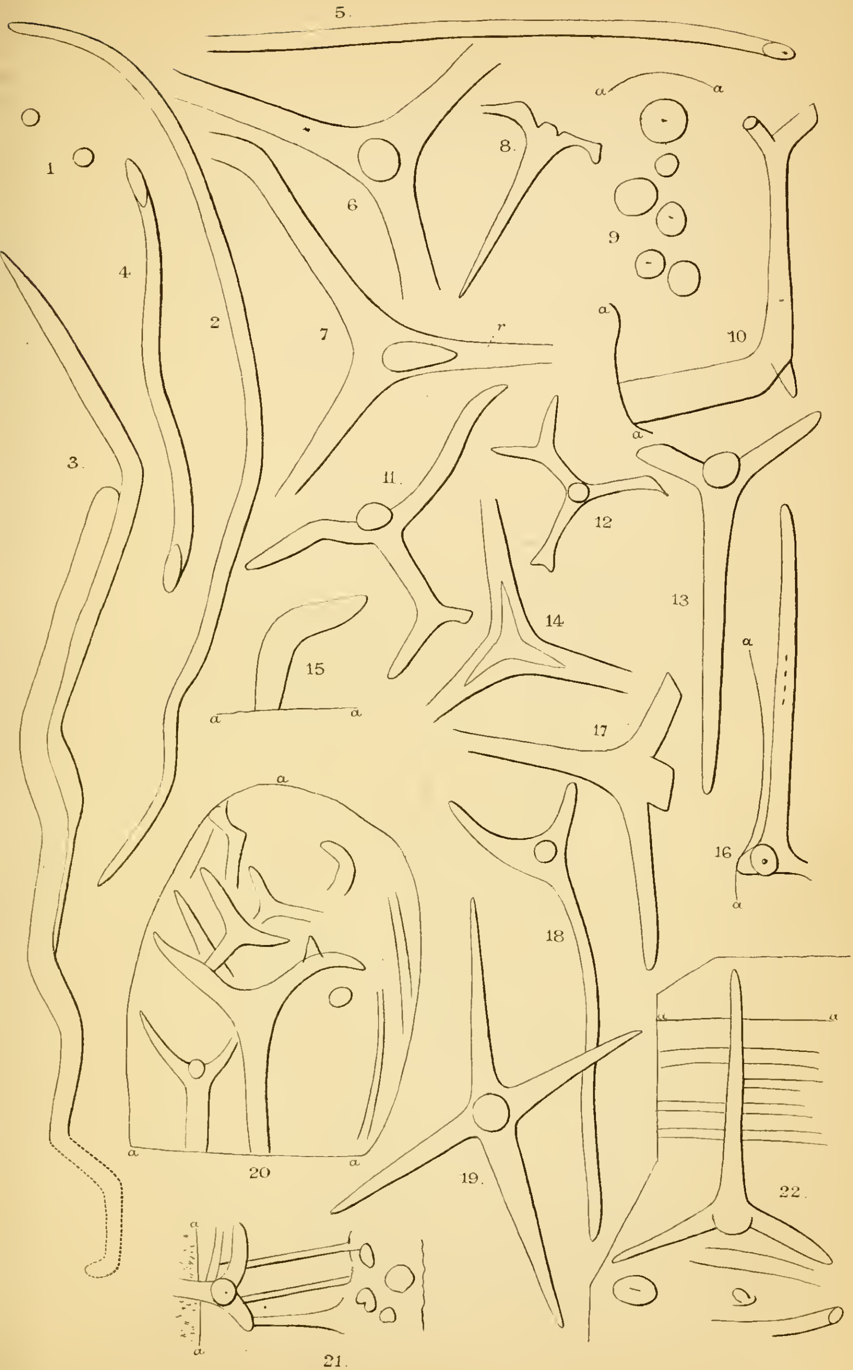

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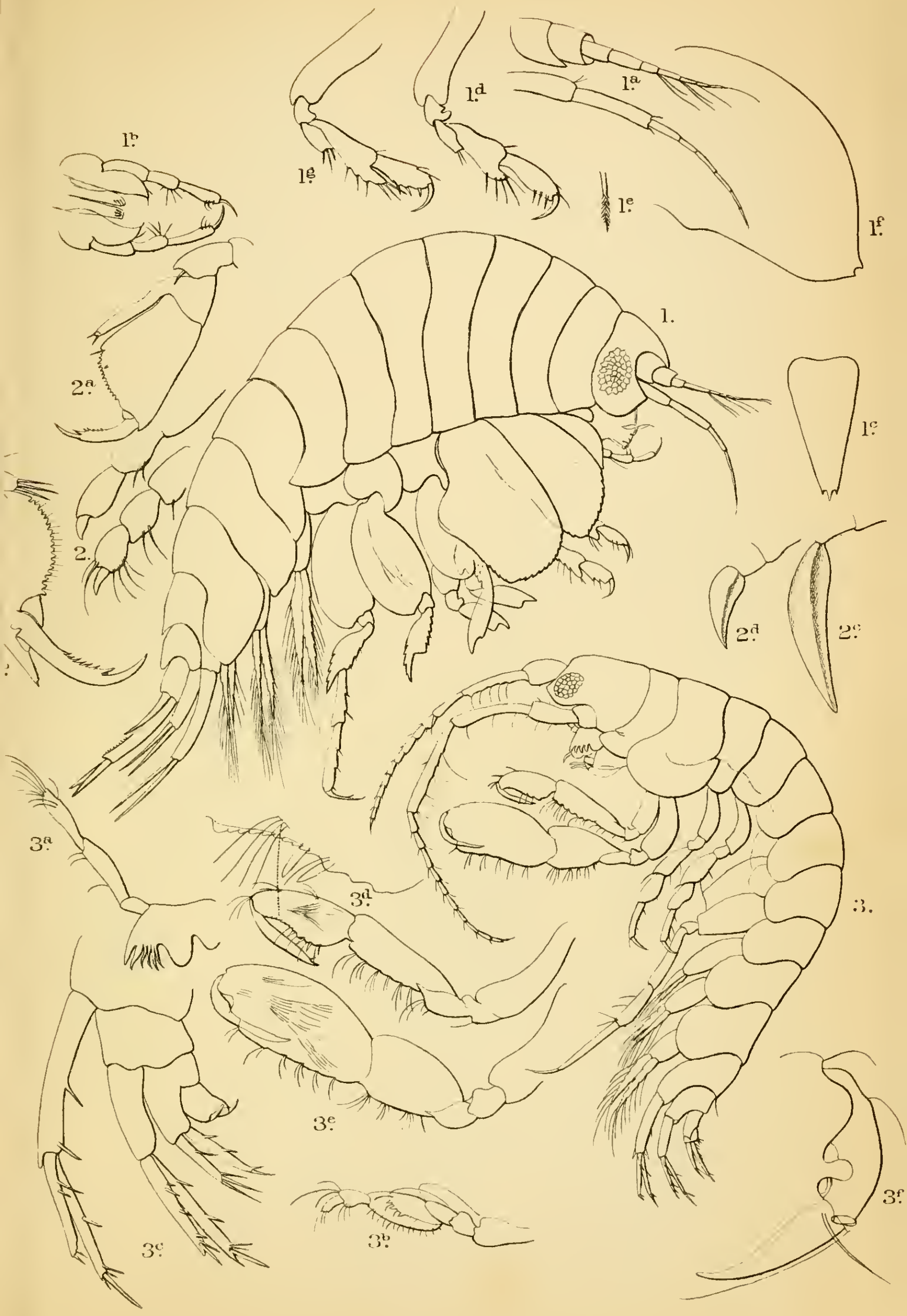
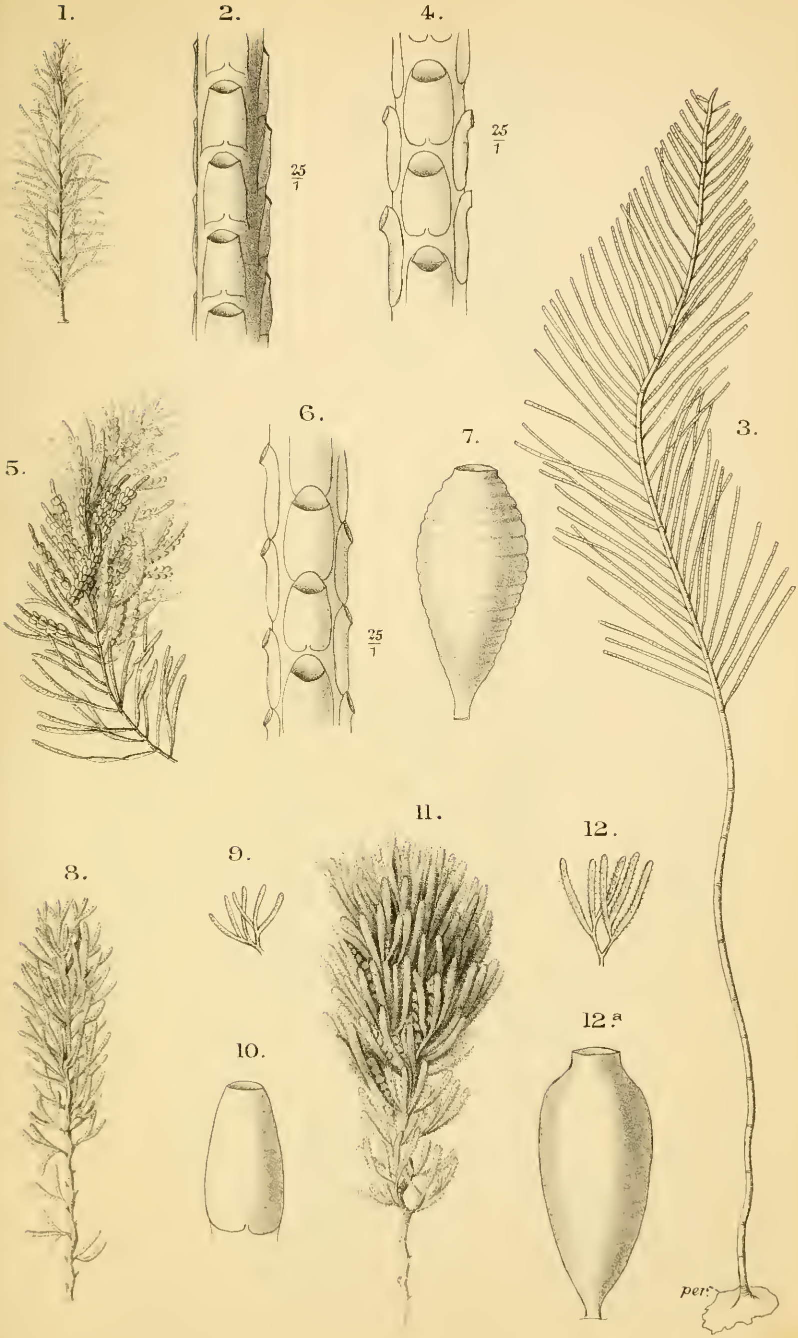
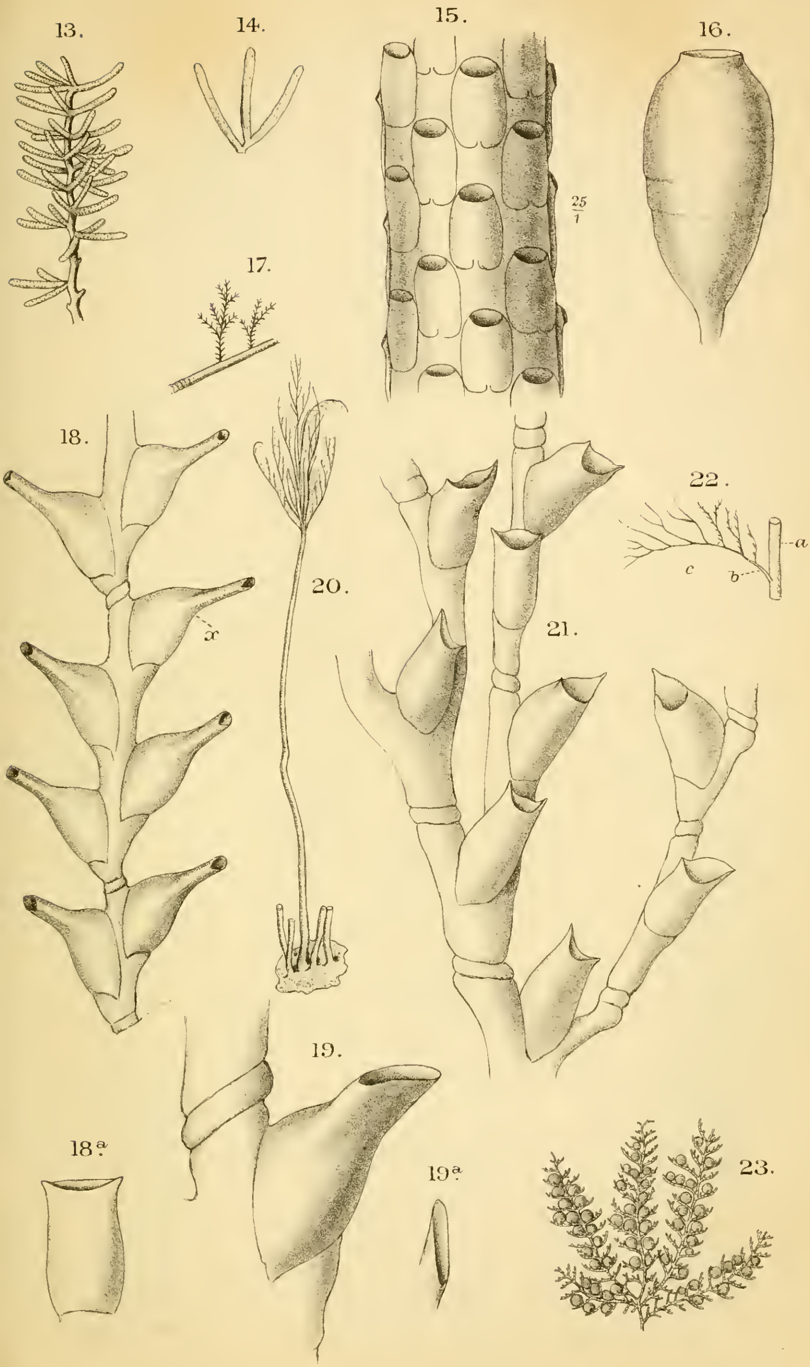


T.R.R.S. del.

Mintern Bros lith.



Mintern Bros. lith.



Mintern Bros. lith.

R. Mintern. lith.

Mintern Bros. imp.