THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

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

CONDUCTED BY

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

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

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

J. TAYLOR, *Norwich*, 1818.

CONTENTS OF VOL. V.

[SIXTH SERIES.]

NUMBER XXV.

NUMBER XXVII.

NUMBER XXVIII.

NUMBER XXIX.

NUMBER XXX.

PLATES IN VOL. V.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

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

No. 25. JANUARY 1890.

I.—*Some Remarks on the Anatomy of* Stephanoceros Eichhornii. By RUPERT VALLENTIN.

[Plates I. & II.]

NOTWITHSTANDING the fact that this Rotifer has been known to exist for nearly one hundred and thirty years, forming as it unquestionably does one of the most interesting objects for microscopical exhibition, still much remains to be learnt concerning its anatomy.

Having recently secured some very large specimens, I naturally consulted the last monograph (1) * with which I am acquainted, and was astonished to find how great were the differences of opinion concerning the most fundamental points of its anatomy. It then occurred to me to try if some of these points could not be determined by means of serial sections, since all other means had failed; and my results, although good, still leave considerable room for improvement.

I assume on the part of the reader a slight acquaintance with the anatomy of the animal, such as may be obtained from any text-book, and so will proceed to discuss those results which my work has so far yielded.

* The numbers refer to Bibliographical List at end.

The Tube.—The tube or case in which the animal usually dwells consists of a jelly-like material, extending from the collar to the extremity of the foot. Into this, when the necessity arises, the animal can retire. It is formed by the young Rotifer soon after its exit from the parent's tube; but whence it originates has hitherto escaped observation. Mr. Jackson (2) says "Some few Rotifera develop round themselves a gelatinous case, which they inhabit permanently (*Floscularia*) or temporarily (*Philodina*), the origin of which is unknown." Dr. Hudson (*loc. cit.*) says, "Neither salivary, gastric, nor foot-glands have been observed in *Stephanoceros*; but, as the animal secretes a large and comparatively solid tube, it is clear it must have some organ for this purpose or that the substance of which the tube is constructed oozes from the surface of the body." The most important observer is Mr. Gosse (*loc. cit.*). He says, "A specimen, which was hatched under my eye, swam for ten minutes, and then became permanently attached to the upper glass of the box, so that it was vertical in position, with the foot next the eye, a favourable aspect for observing the development of the case. It presently began to dilate its body, and, in about five minutes from its attachment, I perceived a distinct filmy ring round it, perfectly circular, whose diameter was about twice that of the body. The little animal now began to lean over to one side, and the ring soon had another segment additional, leaning in the same direction. The case, for such it was, looked like two broad hoops of glass, each swollen in the middle and set one on the other, but not quite concentrically, at least to the eye of the observer. It was manifest that it was produced from an excretion from the body, owing its form and size to the animal's moving round on the foot as on a pivot."

It has been a fact familiar for many years to zoologists that many of the migratory Rotifera possess in the foot glandular bodies, the secretion from which enabled them to fix themselves for a long or short period to any substance.

Dr. Zacharias (3), in his paper on *Rotifer vulgaris*, says, "We know that they [pedal glands] are the seat of a secretory activity, and secrete a sticky product which serves to attach the animal to smooth surfaces."

Eckstein (4) gives a description of glands in the foot of *Floscularia*, and says, "Der Fuss, welcher von einer faltigen Haut bekleidet ist, endigt in zwei sehr kleinen Spitzen, zwischen denen eine etwas längere Röhre hervorragt." He gives a figure of the glands as seen in optical longitudinal section.

With regard to *Stephanoceros*: it seems on the face of

Mr. Gosse's careful observations that the source whence this secretion arises is not from a single spot, but from a considerable area. In a transverse section (Pl. I. figs. 7–9) the four pairs of muscles in the foot will be seen, each interspace being occupied by a cell possessing a nucleus and nucleolus, it being by these that the tube is secreted. The cuticle throughout the entire animal is very thin. Mr. Jackson (*loc. cit.*) says, "The body is protected by a cuticle secreted by an underlying layer of ectodermic protoplasm with scattered nuclei." It seems to me probable that these glandular cells belong to the epidermis, which in other parts of the animal is so indistinct that it is difficult to make it out even with high powers. The "leaning over" and "the moving round on the foot as a pivot" noticed by Mr. Gosse would be for two purposes—the former to solidify the case, and by pressing it down cause it to adhere to any foreign substance; the latter to keep a central space clear, so as to allow the animal sufficient room for its body when contracted. While these processes were in progress the animal would be pouring out a fresh supply, and so we should soon find it possessed of a tube of sufficient strength to afford shelter for the occupant.

Thinking it possible that the above conclusions might be verified by comparison with other species, I cut some serial sections of *Melicerta ringens.* It is well known that the young first secrete a fine tube, and afterwards build a tube of pellets round it externally. Prof. Williamson (5) says, "The animal [*Melicerta*] attaches itself by the tail to some fixed support, and develops from the skin of the posterior portion of its body a thin hyaline cylinder, the dilated extremity of which is attached to the supporting object." On examining sections through the foot I was gratified to find the mucous cells occupying the same position, though reduced one fourth in size, but resembling in every feature those in *Stephanoceros.* I think therefore one may safely assume that the tube in both instances originates from these cells.

Muscles.—This was the first point to which I directed my attention. Dr. Hudson (*loc. cit.*) says, "There are considerable differences of opinion about the muscular system. Dr. Leydig (*loc. cit.*) says that there are four muscles which rise in the foot and each of which divides into a pair as it crosses the trunk, and then subdivides into smaller branches as it passes over the coronal cup to the base of the lobes. Mr. Gosse makes them to be five pairs, and says that usually each pair runs up the trunk from the foot in a line with one of the arms, and then, before reaching it, divides into diverging branches which, at remote points, are united to a muscular collar close to the base of the arms. He notices, however, that he has seen cases where the muscles run down direct from the depressions between the lobes without uniting to form pairs. My own opinion, after prolonged observation of many specimens, is that there are really six pairs of muscles, and that they are arranged in the following fashion. Each pair runs up the foot, looking like a single muscle, and the reason why never more than four (pairs) are visible in the foot from any point of view is that there is always a pair on each side of the animal (however viewed) which is there lost to sight. At the junction of the foot and trunk each pair begins to open a little, and by the time they have reached the bottom of the coronal cup the constituents of each pair diverge obviously from each other, and terminate usually at the base of some one of the depressions between the lobes, but in such a fashion that the constituents of the same pair never end in the same depression."

According to my observations their arrangement is as follows:—On reference to figs. 7–11 (Pl. I.) four pairs of muscles will be seen placed at equal distances from one another almost immediately under the cuticle, the interspaces being occupied by the mucous cells previously mentioned. Owing to the tapering shape of the foot these muscles tend naturally to converge towards the fixed extremity; and so we find that in this latter region they come into contact, the mucous cells disappearing, the apex containing muscles only. At the junction of the foot with the body the muscles of each pair separate a little, and as they run forwards keep close under the cuticle, and never leave their own portion of the body. Anteriorly they terminate in a sphincter-muscle placed in the collar at the bases of the arms. So far as I have been able to gather from previous writers it appears to me that sufficient importance has not been attached to this muscle, styled by Mr. Gosse "circular." On examining a living specimen in a healthy condition, we find that when it retracts into the tube the bases of the arms are brought together by the contraction of this "circular" muscle, and the longitudinal muscles being almost simultaneously brought into play, a rapid retreat of the animal into its tube is the result. The presence of this muscle is also evident when the animal issues forth again, the arms being protruded as a bundle and then opened out, the setæ clothing them being immediately brought into play.

Nervous System.—Dr. Hudson (*loc. cit.*) is the only writer who has hitherto seriously raised the question whether or not that part of the Rotiferon which usually passes as the brain is really a nervous structure. He says, "What is probably the nervous ganglion is a peculiar organ consisting of large clear cells lying at the back of the vestibule near the dorsal surface. Above it and well under the dorsal surface is a three-lobed, granular, semiopaque body with which the nervous ganglion is possibly connected. The nervous ganglion in many of the Rotifera, especially among the Notommatadæ, shows a marked cellular structure at the lower end which loses itself in a granular, semiopaque, upper portion; but it must be admitted that if these peculiar bodies constitute the nervous ganglion of *Stephanoceros*, it is rather their position than their shape and structure that would lead us thus to interpret them." Mr. Cubitt (6) says, "It [the brain] is seated in the anterior region in a dorsal aspect; it is pear-shaped, constricted in the middle, where it supports certain small processes which traverse its substance as well as project beyond. In active individuals the brain is large and prominent, but less conspicuous in others, whose sluggish movements indicate disease or age; its structure is not granular, except at its internal attachment, and is in no way related to the granular layers that occur on each side of it. It presents more the appearance of a cellular structure, but differs essentially from the character of such a structure . . . the divisions incline to a pentagonal arrangement, and each junction or union of the fibres is distinguished by a definite nucleated swelling, faintly resembling Gratiolet's figures of the nerve-cells of the spinal cord." My own observations show the "brain" to be a somewhat cylindrical organ, and the walls to be composed of irregularly-shaped oval cells, each possessing a nucleus and nucleolus. Each cell is wholly or partially filled with granular protoplasm, and as the secretion present in the central space is also granular, one may fairly assume that the granules originated from the cells and that the cells were in an active state at the time of the death of the animal (*vide* Pl. II. figs. 13 and 14). The function of this organ will, I think, be easily demonstrated if we examine the living animal. Dr. Hudson (*loc. cit.*) says, "From the spot where it [the brain] adheres to the wall of the vestibule a sort of protrusile tongue or taster rises, which can be pushed forward so as nearly to fill up the interval between the knobbed ciliated ends of the ciliary wreath. This tongue may be seen incessantly pressing backwards and forwards as the food passes into the vestibule, as if discriminating between the passing atoms, just as the two tasters do in *M. ringens*." Examination of transverse and longitudinal sections shows that the cylindrical organ previously described is open at the upper end, where it communicates with a definite single tube enclosed by thin membranous walls and narrowing towards its distal extremity, where it apparently opens into the retracted vestibule. This tube corresponds in its relations with the so-called "taster" of Dr. Hudson, and is, in my opinion, identical with it. On reference to Pl. II. fig. 14 the opening of this duct into the vestibule can be seen. Fig. 13 shows the proximal extremity of the duct with the secretion therein and its connexion with the apex of the so-called "brain." The suggestion I offer is this: the organ is of a salivary nature, the "tongue" or "taster" being a duct, its use being that as each particle of food is passed into the vestibule a minute portion of this secretion passes with it. This view seems all the more probable when we consider that salivary glands, which are present in the majority of the Rotifera, are absent in this species. Assuming this to be the case, is there any other structure to which one can point as being nervous? This, I think, can be answered in the affirmative. No observer can have failed to notice in the living animal the large, oval, nucleated cells placed close to the cuticle on either side of the collar. Dr. Hudson (*loc. cit.*) says, "oval nucleated cells are also easily seen in the wall of the coronal cup when the animal is viewed from either side." Sections taken in a plane parallel to the long axis of the animal show these to resemble in a marked degree unipolar ganglion-cells; the single process given off from each cell running anteriorly and terminating in the plumes or arms (Pl. II. fig. 1). This appears to receive further confirmation on the examination of *Melicerta ringens*. When this Rotiferon is protruding from its tube, the two paired antennæ placed ventrally, the paired recurved hooks and the rudimentary third antenna placed between them protect it dorsally, and so it is guarded on all sides. Sections show each of these to be furnished with a nerve-fibre, clearly showing their sensory nature. In *Stephanoceros*, however, we find the plumes or arms performing two functions: they act as tactile organs, and, being furnished with setæ, as food-collectors for the animal.

Eyes.—The remarks I have to make regarding these structures do not agree with those made by previous investigators. Dr. Hudson (*loc. cit.*) says, "The eyes lie on either side of the nervous ganglion; they may be seen by a dark field illumination." Mr. Cubitt (*loc. cit.*) gives the most exhaustive account. He says, "Their true character is difficult to determine; they resemble in a marked degree the eyes of Vertebrates, consisting of a globe, sending off posteriorly a fibre to the brain, and possessing anteriorly a pigment-spot, which, while favouring the form of a compound type, contains within itself a central refracting medium." He is uncertain "whether they incline to the simple or compound type; they are eminently calculated to fulfil the purposes they are required to serve, in simply conveying light, though not the perception of objects to the brain, for they possess no choroid."

I must confess that on the strength of the foregoing remarks my curiosity was considerably aroused. I examined my sections taken through the region where, in the living animal, I had seen these red bodies without finding any structure at all agreeing with a visual organ. All that I could find were two spherical bodies, one being placed more superficially than the other, of a chitinous nature, and which, when examined with a dark-ground illumination, resembled in every way the so-called eye. The firmer and more external one is imbedded in a homogeneous structureless mass, which presents at some points certain lines of no definite outline (*vide* Pl. II. fig. 6). The organ appears to be composed of two parts, an outer ring of a highly refractive nature, enclosing a central opaque mass. The second eye is placed deeper in the tissues of the animal, and the homogeneous mass in which it is placed does not appear to possess the firmness noticed in its fellow. The organ is composed of a less dense material, splinters readily under the knife, and shows in consequence its structure admirably. These organs are not present in all my sections. As to their use to the animal I am unable to offer at present any suggestion; but I think one may safely assume they are not visual organs.

Ovary and Development.—The remarks I have to make under this heading are few, but still of considerable interest. The earliest writer, so far as I can find, who has touched upon the origin of the envelope surrounding the ovum is Prof. Huxley. He says (7), "The ova are developed thus:—One of the vesicles increases in size, and reddish elementary granules appear in the homogeneous substance round it. This accumulation increases until the ovum stands out from the surface of the ovary; but invested by its membrane which, as the ovum becomes pinched off as it were, takes the place of a vitellary membrane."

Dr. Zacharias (*loc. cit.*) says, "The process of separation is so effected that a portion of the enveloping membrane of the ovary is separated with it and transferred to the ovum, so that the embryo in its development lies in a completely closed hyaline vesicle, which, from its origin and function, is to be regarded as a real uterus." With these remarks my investigations entirely agree; but, as both the above-mentioned authors obtained their views by means of optical sections, I have thought it desirable to give a figure of it in section, so have placed fig. 18 among my illustrations.

Dr. Hudson (*loc. cit.*) says, "In *Stephanoceros* (as in a few other Rotifera) the young (as Ehrenberg conjectured) is occasionally born alive." In all my serial sections of this Rotifer embryos are found in section in the body-cavity in various stages of development. In the case of some they are in a most advanced condition; the trophi are to all appearance fully formed and in a fit state to allow the Rotiferon to lead a separate existence. They do not appear to occupy any definite space in the body-cavity, being, as stated by Dr. Zacharias (*loc. cit.*), "thrust hither and thither by the movements of the animal." At the same time, however, the fact must not be passed over in silence that the Rotiferon, besides possessing embryos in the body-cavity, also possesses ova within the tube. Unfortunately I have not been successful enough to obtain these latter in section, owing to the tube invariably dissolving during the various treatments the animal has to pass through before it is ready for the microtome. The ovum being simply placed within the cavity of the tube, and not attached to anything, is easily lost.

I have not as yet been fortunate enough to witness the birth of the embryos; bearing in mind their large size and the comparative smallness of the cloacal opening, it seems to me most probable that the parents die, and by their death liberate the enclosed embryos. Quite recently I have on two occasions found in my small aquarium partially decayed specimens, with two, and in some instances three, embryos within the tube, and swimming therein apparently in a healthy condition. These embryos may, however, have been hatched from those eggs within the tube; but in one instance there were within the tube two unhatched eggs which also contained free embryos.

In one series of sections I found an ovum that had formed a gastrula by epibole (Pl. II. fig. 17). Dr. Zacharias has viewed this in *Rotifer vulgaris*, but has given no figure of it. The figure I have given was obtained in section of a specimen, so will confirm his remarks. Unfortunately I have been unable to secure any more specimens containing embryos exhibiting the early segmenting stages; but from those I possess more advanced I am inclined to imagine that after segmentation histolysis sets in and rapidly obliterates the previously existing cells.

Body-cavity.—Mr. Jackson (*loc. cit.*) says, "the cœlome does not extend into it" [the foot]. On reference to figs. 7 and 8 it will be noticed that, owing to the mucous cells failing to meet in the centre, a considerable space exists in this region of the foot. As to whether or not this space is caused by the reagents used I am unable definitely to determine; anyhow, it is present in all my sections, and is also plainly visible in the same region in *Melicerta ringens.* Owing to the tapering shape of the foot this space gradually decreases in size as one passes to the attached extremity; it terminates at the junction of the four pairs of muscles. Anteriorly it continues into the trunk, and thence into the arms, there being, so far as I can discover, no septum dividing them. At first I was inclined to imagine that the reagent used as a stain had failed to affect the protoplasm of the arms; but, on further examination, I found that the arms simply consisted of a delicate cuticle, a continuation from the foot and trunk. Lining this integument is a denser substance, not exhibiting any definite cell-structure. From its greater density I should infer this substance to be a skeletal tissue.

Zoologists seem fairly agreed that there is a fluid within the body of the animal; but as to whether or not the "vibratile tags" with their canals are of the nature of a vascular or excretory system opinions seem fairly divided. When commencing my study of this Rotifer I hoped to obtain some interesting results with regard to these structures; but so far I have failed to find any trace of them in sections. Owing to the hollow nature of the arms one can easily imagine that the animal protrudes from its case by the fluid occupying the body-cavity being forced forward.

Parasites.—In one of my earliest series of sections of this Rotifer I met with a structure in the region of the posterior third of the body which for a considerable time I was unable to explain. It consists of an ovoid body placed directly under the cuticle and sharply divided from the rest of the Rotiferon by a well-defined membrane. Scattered irregularly within this body are numerous cells, varying considerably in size, and placed excentrically is a large ovoid capsule, bounded by a wall of apparently a chitinous nature, a small opening being visible at the point nearest the cuticle. Lining the interior of this capsule is a thin layer of homogeneous protoplasm, from which extends a delicate fringe of cilia which completely fill the cavity (Pl. II. fig. 16). Shortly after I met with Dr. Zacharias's paper, and at once recognized my specimen as a species of *Trypanococcus*, discovered by Prof. von Stein many years ago. In a footnote Dr. Zacharias (*loc. cit.*) says, "On careful examination of fig. 1 (*Stephanoceros Eichhornii*) on the first of the four plates which Prof. Leydig has appended to his fine memoir on the structure and systematic position of the Rotatoria, I see a structure, marked with the letter *h* (on the right at the fore part of the animal), of which the distinguished histologist confesses that its significance was unknown to him. He describes it as 'a group of limpid vesicles which open on the cuticle by a duct, which, although short, is distinct in a suitable position.' Have we not here a similar observation to that which I have frequently made in *Rotifer*?"

There are two points in which this specimen does not agree with the above description. There is no visible duct to the exterior. It is a single vesicle only. I may also remark that I have cut many serial sections of this Rotifer and have only found the parasite present in one instance.

I am now engaged in examining *Melicerta ringens* by means of serial sections, and I hope before long to offer some remarks on that species.

Literature referred to.

(1) Hudson, C. T., and Gosse, P. H. The Rotifera or Wheel-animalcules. 1886.

(2) Rolleston's Forms of Animal Life. By W. H. Jackson. (Rotifera.) 2nd edition. 1888.

(3) Zacharias, O. "On the Reproduction and Development of *Rotifer vulgaris*," Ann. & Mag. Nat. Hist. vol. xv. no. 86. 1885.

(4) Eckstein, K. "Die Rotatorien der Umgegend von Giefsten," Zeitschrift für wissenschaftliche Zoologie, vol. xxxix. 1883.

(5) Williamson, W. C. "On the Anatomy of *Melicerta ringens*," Quart. Journ. Micr. Sci. vol. i. 1853.

(6) Cubitt, C. "Observations on some Points in the Economy of *Stephanoceros*," Monthly Micr. Journ. vol. iii. 1870.

(7) Huxley, T. H. "*Lacinularia socialis*: a Contribution to the Anatomy and Physiology of the Rotifera," Trans. Micr. Soc. Lond. vol. i. 1853.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Section parallel to the long axis of *Stephanoceros*. *a*, unipolar ganglion-cell placed at the base of an arm with single nerve-fibre; B, space in arm (body-cavity); *c*, cuticle; *pe*, setæ; *m*, muscles. Zeiss F, oc. 3.

Fig. 2. A group of unipolar ganglion-cells, showing each ganglion-cell with its single nerve-fibre. Zeiss F, oc. 3.

Fig. 3. Transverse section of Rotiferon. *m*, vestibule; *c*, taster or tongue; *b*, "brain;" *e*, embryos in section; D, calcareous granules; *f*, cuticle. Zeiss C, oc. 3.

Fig. 4. Transverse section of Rotiferon. *a*, external eye; *b*, the deeper eye; *c*, calcareous concretions; D, commencement of mastax; *e*, cuticle. Zeiss C, oc. 3.

Fig. 5. Portion of fig. 3. *a*, deeper eye in median transverse section; *b*, portion splintered off; *c*, external eye; *f*, cuticle. Zeiss F, oc. 3.
Fig. 6. Portion of fig. 4. *a*, fragments of deeper eye; *b*, external eye; *cu*, cuticle. Zeiss F, oc. 3.
Fig. 7. Transverse section of foot immediately beneath the junction with the body. *m*, the four pairs of longitudinal muscles; *m. c.*, mucous cells; *cu*, cuticle. Zeiss F, oc. 3.
Fig. 8. Transverse section of foot three sections lower, showing considerable decrease in size. The lettering as in previous figure. Zeiss F, oc. 3.
Fig. 9. Fifth section of foot. The animal invariably dies with this region of the foot twisted. Zeiss F, oc. 3.
Fig. 10. Seventh section of foot. Zeiss F, oc. 3.
Fig. 11. Extremity of foot. *a*, the cup-like extremity; *b*, union of muscles. Zeiss F, oc. 3.
Fig. 12. Portion of cuticle under high power. *a*, cellular layer; *b* and *c*, granular. Zeiss K, oc. 3.

PLATE II.

Fig. 13. Almost vertical section of Rotiferon. *b*, "brain;" *s*, secretion; *m*, vestibule; *e*, embryo; *ov*, ovary; *cu*, cuticle. Zeiss E, oc. 3.
Fig. 14. Three sections later, showing the connexion between the lumen in the "brain" and the vestibule. Lettering as in previous figure. Zeiss E, oc. 3.
Fig. 15. Median transverse section of "brain." *cu*, cuticle. The secretion in central lumen is not figured. Zeiss F, oc. 3.
Fig. 16. Median transverse section of *Trypanococcus*. *cu*, cuticle of Rotiferon; *a*, cyst containing cilia; *b*, its opening. Zeiss F, oc. 3.
Fig. 17. Formation of gastrula by epibole. Zeiss F, oc. 3.
Fig. 18. Transverse section of ovary. *ov*, ovary; *a*, an ovum; *b*, membrane of ovary being detached with ovum and forming the vitelline membrane. Zeiss F, oc. 3.

II.—*Report upon the Hydrozoa and Polyzoa collected by P. W. Bassett-Smith, Esq., Surgeon R.N., during the Survey of the Tizard and Macclesfield Banks, in the China Sea, by H.M.S. 'Rambler,' Commander W. U. Moore.* By R. KIRKPATRICK.

[Plates III.–V.]

COLLECTIONS of the marine faunas of Tizard and Macclesfield Banks were made by Mr. P. W. Bassett-Smith, and were presented to the British Museum (Natural History) by the Lords of the Admiralty. A list of the Hydrozoa and Polyzoa obtained, with descriptions of new species, is given below.

HYDROZOA.

The collection of Hydrozoa from the Tizard and Macclesfield Banks is a small one, but includes one specimen of great interest, viz. a new species of *Stephanoscyphus*, Allman.

With the exception of a specimen of *Millepora verrucosa*, the Hydrocorallinæ are represented merely by small fragments.

Siphonophora.

Physalia utriculus, Eschscholtz. Off Macclesfield Bank.
Velella, sp. Young forms in the "Rataria" stage.
Porpita, sp. No specimens were preserved, but sketches were taken from life.

Hydrocorallinæ.

Stylaster flabelliformis, M.-Edwards & Haime. Garvan Reef, 2 fath.
—— *pulcher*, Quelch. Garvan Reef, 2 fath.
Distichopora violacea, M.-Edwards & Haime. Garvan Reef, 2 fath.
—— *irregularis*, Moseley. Garvan Reef, 2 fath.
Millepora ramosa, Pallas. Tizard Reef, 10 fath.
—— *verrucosa*, M.-Edwards & Haime. Tizard, ½ fath.

Hydroida.

Sertularia distans, Lamouroux. Tizard, 27 fath.

Aglaophenia MacGillivrayi, Busk. Tizard, 5 and 27 fath.

The specimens of *Aglaophenia* are loaded with corbulæ. They vary slightly from the descriptions of Busk and Allman, but not to the extent of being specifically distinct. In the Tizard specimens the branches are shorter and more rigid, and the ridges of the corbulæ more prominent and interdigitating than in the 'Challenger' one.

Genus Zygophylax, Quelch.

Zygophylax tizardensis, n. sp. (Pl. III. fig. 3.)

Trophosome: colony about 1½ inch in height, the main stem bearing pinnately-disposed alternate ramuli and pinnate branches in one plane. Main stem polysiphonic, branches gradually becoming monosiphonic towards the periphery.

Hydrothecæ half-immersed on main stem, free and substipitate on branches; oral end bent outwards and constricted at the bend; one or two annuli concentric with margin of orifice; with a knobbed chitinous ring internally at the base and a half-ring at the upper dorsal part, for muscular attachments. Length of hydrothecæ ·4 to ·5 millim., breadth ·1 millim.

Sarcothecæ numerous, cylindrical, varying in length from ·1 to ·4 millim., on the tubes composing the main stem and larger branches; a pair at the base of each hydrotheca.

Gonosome unknown.

Hab. Tizard Reef, 35 fath.

The type of the genus *Zygophylax* is *Z. profunda*, Quelch*, from Cape-Verde Islands, 500 fath.

The nearest ally to *Zygophylax* is the genus *Perisiphonia*† of Allman; in the latter the colony is polysiphonic throughout. The genus *Cryptolaria* includes forms in which the colony is entirely polysiphonic (as in *Cryptolaria prima*, Busk) and others in which it becomes monosiphonic towards the periphery. It would appear, then, that *Perisiphonia* is synonymous with *Zygophylax*.

The knobbed ring at the base of the hydrotheca in *Z. tizardensis* gives attachment to muscular fasciculi which unite to form a sheath (retractor muscle) surrounding the offset of the cœnosarc as it enters the hydrotheca; the protractor muscle is attached to the chitinous half-ring on the upper dorsal part of the hydrotheca.

Genus Stephanoscyphus, Allman.

Stephanoscyphus, Allman, Trans. Linn. Soc., 2nd ser. Zoology, vol. i. 1875, p. 61.

Stephanoscyphus Allmani, n. sp. (Pl. III. fig. 1.)

Perisarc consisting of a monosiphonic, stout, irregularly-branched stem, straggling, flexible, partly decumbent, partly free; about ·9 millim. in diameter, marked with circular rugæ and longitudinal striæ.

Hydrothecæ sessile, arranged in half-verticils on decumbent part, and in verticils of from three to five in free portions of stem; expanding gradually from base upwards, from 3–6 millim. in height, with strongly marked circular rugæ, connected by parallel longitudinal striæ. Inside the hydrothecæ a vertical chitinous lamella expanding into a funnel or basin, with thick, free, fimbriated edge closing in about three fourths of the lumen of the tube; sometimes a second chitinous process higher up in the tube.

Hab. Tizard Reef, 27 fath.

In consideration of the interest taken by Prof. Allman in

* Ann. & Mag. Nat. Hist. (5) xvi. 1885, p. 4, pl. i. fig. 4.

† 'Challenger' Report on Hydroida, pt. ii. p. 43.

the affinities of *Stephanoscyphus*, the specimen was sent to him for inspection. He replied that the material was not sufficiently well preserved for the exposition of anatomical details.

The specimen consists of four pieces from 2 to 6 inches in length, the colour varying from dark to pale brown.

Many of the hydrothecæ are empty, and where the polypites are present they are fully retracted, with the tentacles introverted.

The four longitudinal markings in the gastric cavity of the polypite are in some cases plainly visible; but whether these are solid projections of the mesoderm lined by endoderm, or canals lined by endoderm, owing to the state of preservation of the soft tissues it is not possible definitely to decide.

The main distinction between *Stephanoscyphus* and the closely allied genus *Spongicola* of F. E. Schulze* consists in the presence of a hypostome in the latter. So far as can be made out from preparations of *Stephanoscyphus Allmani*, the tentacles arise from the edge of the orifice of the invaginated polypite, and consequently there is no hypostome.

The internal chitinous projections of the perisarc have a remarkable shape in the new species, and are single on one plane. In the Mediterranean species usually four processes project inwards in the same plane, and two or three such partitions may be present in one hydrotheca. The presence of the chitinous processes probably arises from the necessity for support of the soft tissues, which otherwise could not have well maintained their position in the wide funnel-shaped tubes characteristic of the Spongicolidæ.

The specimens of *Stephanoscyphus* † *simplex* ‡, Allman (sp. MS.?) (Pl. III. fig. 2), dredged by H.M.S. 'Valorous' in 1450 fath., North Atlantic, lat. 56° 11′ N., 37° 41′ W., consist of single funnel-shaped tubes attached to pebbles by a slightly expanded base.

The internal chitinous processes in this species form hemispherical swellings, four being formed on the same plane. These isolated hydrothecæ may be the initial stage of colonial forms, since solitary hydrothecæ of *S. Allmani* were found on shells from the Tizard Bank.

Claus § places *Stephanoscyphus mirabilis*, Allman, and *Spongicola fistularis*, Schulze, in the family Spongicolidæ.

* F. E. Schulze, "*Spongicola fistularis*, ein in Spongien wohnendes Hydrozoon," Archiv mikr. Anat. Bd. xiii. 1877, p. 795, Taf. xlv.–xlvii.

† Proc. Roy. Soc. Lond. 1876, vol. xxv. p. 223.

‡ The specific name "*simplex*" is on the bottle containing the specimen; but I have not seen a published description of that species.

§ Claus, 'Grundzüge der Zoologie' (1880), p. 262.

The choice of this name is somewhat unfortunate, since, although the Mediterranean forms are commensal with sponges, the specimen from the China Sea has not formed an alliance of this nature. Claus ranks the Spongicolidæ under the order Tubulariæ, and brackets the latter with the Gymnoblastea of Allman. But Allman defines the Gymnoblastea as Hydroida destitute of a hydrotheca, whereas in the Spongicolidæ the hydrotheca is a most conspicuous object. The misinterpretation probably arose from confusing the hydrotheca with the hydrophyton. The sessile tubes (hydrothecæ) of *Stephanoscyphus* can scarcely be considered homologous with the tubes of *Tubularia*.

In its general appearance *Stephanoscyphus Allmani* resembles a Calyptoblastic Hydroid of the *Lafoëa* type. Prof. Allman is of opinion that whether the ridges in the gastric cavity have a lumen or not, the Spongicolidæ should be separated from the Gymnoblastea and Calyptoblastea. Prof. Schulze concludes the paper embodying his researches on *Spongicola fistularis* with the following observations * : —

"It seems we can speak from abundant evidence that *Spongicola fistularis* is the *Scyphistoma* form of an Acraspedote Medusa; nevertheless I repeat that we must first investigate the whole generation-cycle before the true position of this form can be determined."

The specimen of *Stephanoscyphus Allmani* does not furnish us with any further data which would help to satisfactorily solve the problem of the systematic position of the Spongicolidæ. Since there are objections to classing this family under the Gymnoblastea and Calyptoblastea, it will be advisable to retain the order Thecomedusæ (Allman), though this has been objected to by Claus.

Order THECOMEDUSÆ, Allman.

Family **Spongicolidæ**, Claus.

Genus STEPHANOSCYPHUS, Allman.

Stephanoscyphus mirabilis, Allman.

Stephanoscyphus simplex, Allman.

Stephanoscyphus Allmani, n. sp.

Genus SPONGICOLA, F. E. Schulze.

Spongicola fistularis, F. E. Schulze.

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* Arch. mikr. Anat. Bd. xiii. p. 816.

POLYZOA.

Chilostomata.

Ætea truncata, Landsborough. Tizard, 27 fath.
Eucratea chelata, Linnæus. Tizard, 2 fath.
Catenicella elegans, Busk. Tizard, 6 fath.
Catenaria otophora, n. sp. Tizard, 27 fath.
Farcimia cereus, Pourtales. Tizard, 6 fath.
Scrupocellaria cyclostoma, Busk. Tizard, 27 fath.
—— *securifera*, Busk. Tizard, 27 fath.
Caberea lata, Busk. Tizard, 27 fath.
Bugula scaphoides, n. sp. Tizard, 27 fath.
Didymia simplex, Busk. Tizard, 27 fath.
Membranipora crassimarginata, Hincks. Tizard, 27 fath.
—— *hastilis*, n. sp. Tizard, 27 fath.
Cribrilina radiata, Moll. Tizard and Macclesfield, 5–30 fath.
—— *annulata*, Fabricius, var. *setosa* (nov.). Tizard, 27 fath.
Steganoporella magnilabris, Busk. Tizard, 27 fath.
Thalamoporella Rozieri, Audouin. Tizard, 27 fath.
Smittipora antiqua, Busk. Tizard, 27 fath.; Macclesfield, 36 fath.
Microporella ciliata, Pallas. Tizard, 27 fath.
—— *Malusii*, Audouin. Tizard, 27 fath.
—— *violacea*, Johnston, var. *plagiopora*, Busk. Tizard, 27 fath.
—— *coscinophora*, Reuss. Tizard, 35 fath.
Chorizopora Brongniartii, Audouin. Tizard, 27 fath.
Tubucellaria cereoides, Ellis & Solander. Tizard, 27 fath.
Lepralia foraminigera, Hincks, var. Tizard, 35 fath.
—— *lonchæa*, Busk. Tizard, 27 fath.; Macclesfield, 36 fath.
—— *quadrata*, Busk. Tizard, 27 fath.
—— *Poissonii*, Audouin. Tizard, 27 fath.
—— *turrita*, Smitt. Tizard, 27 fath.
—— *onucha*, n. sp. Macclesfield, 36 fath.
—— *cleidostoma*, Smitt. Tizard, 27 fath.
Phylactella geometrica, n. sp. Macclesfield, 36 fath.
Mucronella Thenardii, Audouin. Tizard, 27 fath.
Smittia rostriformis, Kirkpatrick (var.). Tizard, 27 fath.
—— *reticulata*, J. MacGillivray. Tizard, 27 fath.
Porella malleolus, Hincks. Tizard, 27 fath.
Schizoporella Cecilii, Audouin (var.). Tizard, 27 fath.
—— *unicornis*, Johnston. Tizard, 27 fath.

Schizoporella venusta, Norman. Tizard, 27 fath.
—— *lyncoides*, Ridley. Tizard, 27 fath.
Mastigophora Dutertrei, Audouin. Tizard, 27 fath.
Retepora monilifera, P. MacGillivray. Macclesfield, 27 fath.
—— *phœnicea*, Busk. Tizard, 35 fath.
—— *pectinata*, n. sp. Macclesfield, 27 fath.
Cellepora Costazii, Audouin. Tizard, 27 fath.

Cyclostomata.

Crisia setosa, P. MacGillivray. Tizard, 27 fath.
—— *elongata*, M.-Edwards. Tizard, 27 fath.
Stomatopora granulata, M.-Edwards. Tizard, 27 fath.
Idmonea pulcherrima, n. sp. Tizard, 6 fath.
Diastopora sarniensis, Norman. Tizard, 27 fath.
Lichenopora simplex, Busk. Tizard, 2 fath.
—— *capillata*, n. sp. Garvan, 6 fath.

Ctenostomata.

Valkeria uva, Linnæus. Tizard, 27 fath.
Flustrella flabellaris, n. sp. Tizard, 32 fath.
Cylindrœcium dilatatum, Hincks (var.). Tizard, 27 fath.
Buskia setigera, Hincks. Tizard, 27 fath.

Pedicellinidæ.

Barentsia gracilis, Sars. Tizard, 27 fath.
—— *discreta*, Busk. Tizard, 27 fath.

Loxosomidæ.

Loxosoma crassicauda, Salensky (? sp.). Tizard, 27 fath.

Catenicella elegans, Busk.

The specimen consists only of a small fragment. The cells are very minute and transparent; but, apart from the difference in size of the cells, the specimen possesses all the characters of *C. elegans*.

Hab. Tizard Reef, 6 fath.

Catenaria otophora, n. sp. (Pl. V. figs. 1–1 *c*.)

Zoarium slender. Zoœcia in single series, not geminate, with horny joints; long, ovate, produced below into a hyaline tube forming an obtuse angle with the body; front surface flat and punctured, dorsal surface smooth, ventricose; lateral surfaces with three large round pores; orifice subquadrate, with a concave lower border.

A small vertically-placed avicularium with pointed mandible on each side of the oral end of the cell.

Hab. Growing on Algæ, Tizard Reef, 27 fath.

Bugula scaphoides, n. sp. (Pl. IV. fig. 1.)

Zoarium reddish brown; branches slender, spreading horizontally; about eight to ten cells to each internode; zoœcia alternate, boat-shaped, broad at the oral end, much contracted below, the area occupying almost the whole front of the cell; small stalked avicularia very convex dorsally, and with curved beaks, rising from the narrow produced portion of the cell.

Oœcium? Stout branching chitinous tubes given off from the dorsum of each cell.

Dimensions of zoœcium: length ·9 mm., breadth 2 mm.

" " avicularia: length ·08 mm., breadth ·04 mm., height (including stalk) ·08 mm.

Hab. Tizard Reef, 27 fath.

Membranipora hastilis, n. sp. (Pl. V. fig. 3.)

Zoarium incrusting. Zoœcia large, oval; front entirely membranous; operculum without a hinge; placed transversely at the head of each zoœcium an ear-shaped vibracular cell, toothed on one margin, with a vibraculum shaped like a double-edged spear.

Hab. Incrusting coral; Macclesfield, 36 fath.

In the position and shape of the vibraculum this species resembles certain forms of *Cupularia*. The present form is simply incrusting, the zoarium not presenting any definite shape.

Cribrilina annulata, Fabricius, var. *setosa*, n. var. (Pl. V. fig. 4.)

The zoœcia are large, with from 6–8 rows of pores on each side of a slightly marked central ridge. The proximal border of the orifice is pectinate. At the head of each zoœcium a small square avicularian cell, with an acute vibraculoid mandible.

Hab. Incrusting shell; Tizard, 27 fath.

Microporella coscinophora, Reuss, var. (Pl. IV. figs. 5, 5 *a*.)

Eschara coscinophora, Reuss, Foss. W. Tertiärb. p. 67, pl. viii. fig. 20; Stoliczka, Sitzungsb. Akad. Wiss. Wien, Bd. xiv. Abth. 1, 1862, pl. ii. fig. 11, pl. iii. figs. 1, 2.

Zoarium forming slender, flat, bilaminate branches, from 1 to 1·5 mm. in diameter; front surface of young marginal zoœcia with from 4–8 circular stellate pores; orifice semicircular with straight lower border, at each end of which is a small avicularium with a small pointed mandible; in older cells the surface of the zoœcium is sunk at the bottom of an oval depression, and one of the lateral avicularia rises on a calcareous stalk to a level with the general surface; a row of small avicularia present along the margins of the branches, and occasionally at the bases of the zoœcia.

Hab. Tizard Reef, 35 fath.

The Tizard-Reef specimen closely resembles Stoliczka's figure in Sitz. Ak. Wiss. Wien, Bd. xiv. pl. iii. fig. 1. Here there is a knob rising from the centre of a dark depression.

Lepralia lonchæa, Busk.

Lepralia lonchæa, Busk, Chall. Rep. p. 146.
Lepralia vestita, Hincks, Ann. & Mag. Nat. Hist. (5) 1885, xv. p. 256, pl. ix.

Mr. Waters, in his Supplementary Report on the 'Challenger' Polyzoa (p. 28), remarks that, without a more complete examination, he is unable to decide whether or not these two forms are identical. A plentiful supply of material enables me to state that the two species are synonymous. The opercula vary slightly in appearance, according to the mode of preparation; but the same variations (in appearance only) were obtained both in specimens from the Tizard Bank and from the 'Challenger' collection. Further, Mr. Hincks's description applies in every detail to the specimens from the China Sea.

Hab. Tizard Reef, 27 fath.

Lepralia foraminigera, Hincks, var.

Lepralia foraminigera, Hincks, Ann. & Mag. Nat. Hist. (5) 1883, xi. p. 200, pl. vii. fig. 1.

Hab. Incrusting coral, Tizard Reef, 35 fath.

The variation consists in the presence of a peristome laterally and behind the mouth, and of an avicularium shaped like the spout of a jug, with a long narrow acute mandible, on the front wall of the cell.

Lepralia quadrata, Busk. (Pl. V. figs. 2, 2 *b*.)

Mucronella quadrata, Busk, Chall. Rep. p. 156, pl. xvii.

This species is removed from the genus *Mucronella* because it does not possess the feature characteristic of that genus, viz. a mucro. The process present on the proximal border of the orifice is a prolongation of the front wall of the zoœcium, which fits into a concavity in the operculum. The operculum possesses a peculiar framework. The ovicells are of immense size in comparison with the zoœcia, and the orifices and opercula of fertile zoœcia are enlarged and modified.

Hab. Tizard Reef, 27 fath.

Lepralia onucha, n. sp. (Pl. V. figs. 5, 5 *a*.)

Zoarium incrusting. Zoœcia dull brown, ·8 mm. long by ·5 broad; surface flattened, rising at the oral end; walls thick, opaque, smooth, glistening; orifice rectangular, ·2 mm. in length by ·14 mm. in breadth, with slightly concave lower border, surrounded at the sides and back by a low peristome. Avicularia 0. Oœcium forming an ill-defined swelling at the back of the peristome.

Operculum rectangular, ·2 mm. in length by ·14 mm. in breadth; with a thick rim surrounding the proximal half, with knobs for muscle attachment; giving off from about the middle of the upper surface a chitinous claw, which fits posteriorly into a groove in the peristome.

Hab. Incrusting coral; Macclesfield, 36 fath.

Phylactella geometrica, n. sp. (Pl. V. figs. 7–7 *c*.)

Zoarium incrusting. Zoœcia ovate-elongate, slightly ventricose; front wall smooth, hyaline, bounded by an areolated margin; zoœcia rising anteriorly to a tall cylindrical peristome; primary orifice quadrangular, with three denticles; by the side of the peristome a shallow rudimentary avicularium (in many cases aborted or absent), with broad pyriform mandible.

Oœcium globose, punctured, hyaline.

Hab. Incrusting coral; Tizard Reef, 35 fath.

Mucronella Thenardii, Audouin. (Pl. IV. figs. 2–2 *b*.)

Flustra Thenardii, Audouin; Savigny, Descr. de l'Egypte, pl. x. figs. 3, 3 *a*.

Zoarium incrusting. Zoœcia large, ventricose, with thick glassy walls, perforated by large round pores; from the middle of the lower border of the orifice a stout tridentate or cross-shaped process arises.

Orifice quadrate, with a central hammer-shaped and two lateral sharp incurved denticles; gigantic avicularia, projecting obliquely forwards, with large spatulate mandibles.

Oœcium subglobose, prominent, slightly flattened in front; perforated by numerous pores, giving it a frosted appearance.

Hab. Tizard Reef, 6 fath.

Smittia rostriformis, Kirkpatrick.

Hab. Tizard Reef, 27 fath.

The specimen from the Tizard Reef varies slightly from the type specimen from Mauritius. The avicularium in the former does not project vertically upwards from the front of oœcium, but is situated obliquely along the border.

Schizoporella Cecilii, Audouin, var. (Pl. V. fig. 8.)

The specimen illustrates in a striking manner the transition from the zoœcial to the avicularian cell. The avicularia differ externally from the zoœcia in the prolongation of the operculum into a broad spatulate mandible and in the presence of from four to six short spines round the upper margin of the cell. The notch in the orifice and the separable opercular shaft which fits into it are present both in the zoœcial and avicularian cells.

Hab. Incrusting coral, Tizard Reef, 6 fath.

Retepora pectinata, n. sp. (Pl. V. figs. 6–6 *c*.)

Zoarium slender, branching freely without forming fenestræ; zoœcia flat, smooth, rhomboidal, rising anteriorly to a tall tubular hyaline peristome, equal in height to the length of the cell: summit of peristome denticulate, within the margin a circle of horizontal denticles. On the front of the body of the cell a small avicularium with a short broad spatulate mandible. Dorsal surface vibicate, showing areas of the individual zoœcia; small avicularia scattered about.

Oœcium very small, globular, hyaline, with a faintly marked vertical ridge, from each side of which radiate concentric striæ. Chitinous appendages. Operculum quadrangular; length ·08 mm., breadth ·06 mm.

Hab. Growing on *Retepora monilifera*; Macclesfield, 27 fath.

The single specimen of this beautiful species is about half an inch in height.

In the mode of branching, and in the presence of a high tubular peristome, the specimen resembles *Turritigera stellata*, Busk. The remarkable position of the ovicells in the latter species, as elucidated by Mr. Waters (Suppl. Rep. 'Challenger' Polyzoa, p. 22, pl. i. figs. 22, 25), separates *Turritigera* from *Retepora*. *Retepora pectinata*, though branching freely, and with the tubular peristome, is not classed under *Turritigera*, because its oœcium is in the usual position.

Idmonea pulcherrima, n. sp. (Pl. IV. figs. 6–6 *b*.)

Zoarium decumbent, dichotomously branched; the branches occasionally united by cross bars. Zoœcia rather large, in alternate series of two or three, increasing in height from within outward, hyaline, punctured.

Dorsal surface punctured, marked with longitudinal lines and faint concentric striæ, with calcareous radical processes.

Oœcium forming a flattened punctured inflation, whence arises a curved tube expanded at the orifice, and with the margins rolled out.

Hab. Tizard Reef, 6 fath.

In this species the oœcial orifice has become greatly modified. In the specimen all the orifices are turned in one direction, towards the periphery of the colony.

Diastopora sarniensis, Norman.

Diastopora sarniensis, Norman, Ann. Nat. Hist. (3) xiii. p. 89, pl. xi. figs. 4–6; Hincks, Brit. Mar. Pol. p. 463, pl. lxvi. figs. 7–9.

Hab. Growing on coralline; Macclesfield, 36 fath.

The tubules do not project from the summit of operculate zoœcia, as they generally do in British specimens, but are within the zoœcial tubes and concentric with them. If these tubes are vasa deferentia, the specimen is monœcious, since ovicells are also present on the zoarium.

Lichenopora capillata, n. sp. (Pl. IV. figs. 4, 4 *a*.)

Zoarium composed of confluent disks (meandrine), concave in the centre, with a somewhat thick laminar margin.

Zoœcia in uniserial radiating series, with two or three rows of cancelli between. Zoœcial orifices oval, much produced on the central side, with from 6–12 fine setose processes on the margin; numerous calcareous bristles growing from the body-wall. Cancelli rounded, about half the diameter of the zoœcia.

Oœcia scattered, each forming a conical swelling, produced into a wide tubular orifice.

Hab. Garvan Reef, 6 fath.

Flustrella flabellaris, n. sp. (Pl. IV. figs. 3, 3 *a*.)

Zoarium brown, forming a flat soft flexible expansion, loosely adnate to the surface on which it grows, extending by narrow ligulate anastomosing processes. Zoœcia large, long, hexagonal, 1·2 mm. by ·6 mm., flattened, rising at the oral end to a tall tube (·6 mm. in height in retracted state), with flat sides. No spines. Ctenostome? Tentacles of polypide 20.

Hab. Growing over a sponge (*Axinella*); Tizard, 32 fath.

Loxosoma crassicauda, Salensky, ? sp.

Loxosoma crassicauda, Salensky, Ann. Sci. Nat. 6 série, vol. v. p. 2, pl. xii. figs. 1, 2; Etudes sur les Bryozaires Entoproctes.

The specimens have the tentacles retracted, so that it is difficult to accurately determine the number of them. In general appearance, in the relation of the stalks to the polypides, in the arrangement of the buds, and in the absence of a basal peduncular gland, the specimens answer to the description of *L. crassicauda*. The material is scarcely sufficient for the purpose of making a satisfactory diagnosis.

Hab. Growing on algæ; Tizard Reef, 27 fath.

EXPLANATION OF THE PLATES.

Plate III.

Fig. 1. *Stephanoscyphus Allmani*, n. sp., natural size. 1 *a*. Hydrotheca, showing the polyp with gastral ridges and introverted tentacles, × 60 diam. 1 *b*. Section of hydrotheca, showing internal chitinous processes, × 60 diam.

Fig. 2. *Stephanoscyphus simplex*, Allman, natural size. 2 *a*. Section of hydrotheca, × 60 diam.

Fig. 3. *Zygophylax tizardensis*, n. sp., natural size. 3 *a*. Branch, × 40. 3 *b*. Showing paired basal sarcothecæ. 3 *c*. Portion of a main branch, showing bundles of tubes from which arise sarcothecæ. 3 *d*. Hydrotheca, × 100 diam.

Plate IV.

Fig. 1. *Bugula scaphoides*, n. sp., × 60 diam.

Fig. 2. *Mucronella Thenardii*, Audouin. 2 *a*. Tridentate orifice. 2 *b*. Mandible.

Fig. 3. *Flustrella flabellaris*, natural size. 3 *a*. Ditto, × 60 diam.

Fig. 4. *Lichenopora capillata*, × 4 diam. 4 *a*. Zoœcium, × 60. 4 *b*. Oœcium, × 30.

Figs. 5, 5 *a*. *Microporella coscinophora*, Reuss.

Fig. 6. *Idmonea pulcherrima*, natural size. 6 *a*. Oœcium. 6 *b*. Oœcial orifice.

PLATE V.

Figs. 1, 1 *a*, 1 *b*. *Catenaria otophora*, n. sp. 1 *c*. Operculum.
Fig. 2. *Lepralia quadrata*, Busk. 2 *a*. Operculum. 2 *b*. Operculum of fertile cells.
Fig. 3. *Membranipora hastilis*, n. sp.
Fig. 4. *Cribrilina annulata*, Fabricius, var. *setosa*.
Fig. 5. *Lepralia onucha*, n. sp. 5 *a*. Operculum.
Fig. 6. *Retepora pectinata*, n. sp., natural size. 6 *a*, 6 *b*. Anterior and dorsal surfaces, × 60 diam. 6 *c*. Operculum.
Fig. 7. *Phylactella geometrica*, n. sp. 7 *a*. Tridentate orifice. 7 *b*. Operculum. 7 *c*. Mandible.
Fig. 8. *Schizoporella Cecilii*, Audouin, var.

III.—*Descriptions of twelve new Species of* Lycænidæ *from West Africa and one from the Solomon Islands, in the Collection of Herbert Druce.* By HAMILTON H. DRUCE, F.E.S.

1. *Epitola pinodes*, sp. n.

♂. Upperside dull black. Fore wing with a patch of scarcely perceptible dull bluish scales in and below the cell. Hind wing more or less covered with dull bluish scales, excepting the margins.

Underside dull light reddish brown. Fore wing with the lower half black, extending from the base to near the outer margin. Hind wing with no markings.

Head, thorax, and abdomen black; legs black, with white spots; antennæ black above, alternately spotted with black and white below.

Expanse $1\frac{3}{5}$ inch.

Hab. W. Africa, Lagos.

This species is not nearly allied to any other, but in form and size approaches *E. dunia*, Kirby.

2. *Lycænesthes lithas*, sp. n.

♂. Upperside.—Fore wing dull glossy brown, darker on the costal and outer margins; bright violaceous from the base along the inner margin, extending upwards into the cell and bordered by the lower median nervule. Hind wing bright violaceous, apex tipped with brown; the margin very narrowly black from the apex to the anal angle; the inner margin covered with whitish hairs.

Underside brownish white, with light brown lunular markings, bordered outwardly with white, viz. a mark at the end of the cell, beyond that an irregular band reaching from the costa, where it is narrowest, and gradually widening towards the inner margin; beyond this a marginal row of lunules. Hind wing: a mark at the end of the cell and an irregular rather broad band beyond, darker towards the anal margin; a dark spot near the base just below the subcostal nervure and a smaller one near the base close to the anal margin; two small orange spots with silvery blue scales at the anal angle.

Expanse $1\frac{2}{5}$ inch.

Hab. W. Africa, Addah.

This species is allied to *L. thyrsis*, Kirby, but is violet in place of blue above, and on the underside the markings are much larger.

3. *Pithecops steirema*, sp. n.

♂ ♀. Upperside dull black, with a broad white oval band extending from the subcostal nervure in the fore wing to about the second subcostal nervule in the hind wing.

Underside.—Fore wing white, with the costal margin very narrowly, the apex and outer margin rather broadly, black; several small black spots on the costal margin. Hind wing white, with a large black spot near the centre of the inner margin; the outer margin rather broadly black.

A row of black lunules common to the outer margins of both wings bordered inwardly and outwardly with white. Head, thorax, and abdomen black above, white below; legs white; antennæ black, spotted with white below.

Expanse $1\frac{1}{2}$ inch.

Hab. Solomon Islands.

4. *Larinopoda aspidos*, sp. n.

♂. Upperside.—Fore wing white, the costal margin narrowly, the apex and outer margin rather broadly, bordered with dull blackish brown. Hind wing white, bordered with blackish brown from the apex to the anal angle.

Underside.—Fore wing as above, with a brownish spot at the end of the cell adjoining the costal border. Hind wing bordered as above, with the dark patch near the apex (which is so conspicuous in *L. lircæa*, Hew.) included in the marginal border; a large black spot between the cell and the inner margin, but no spot in the cell.

♀. Upperside.—Fore wing as in male, but rather more narrowly bordered, the border scarcely reaching to the anal angle. Hind wings pure white, with the fringe only brownish.

Underside.—Fore wings as above. Hind wings bordered with blackish brown from the apex to the anal angle, but less broadly than in the male, so that the apical patch is left almost free. There is also the black spot between the cell and the inner margin.

Head black; thorax and abdomen whitish; legs and palpi yellowish red; antennæ black, annulate with white.

Expanse $1\frac{4}{5}$–$1\frac{3}{5}$ inch.

Hab. W. Africa, Lagos.

This species, although allied to *L. varipes*, Kirby, can be readily distinguished by its much broader borders and by the absence of any spot in the cell of the hind wing below, in that respect approaching *L. lircæa*, Hew., from Old Calabar. I may also add that in the eight specimens I have examined (five males, three females) there is no appreciable difference in the width of the border, and the spots below are identical in all cases.

5. *Spalgis lemolea*, sp. n.

♂. Upperside.—Fore wing white, the base, costa, apex, and anterior margin rather broadly brown. Hind wing white, with a well-marked minute black line running along the margin from the apex to the anal angle, thickening slightly at each nervule.

Underside white, with rows of thin, irregular, brown lines, much as in *S. epius*, Westw., but less thickly covered. The marginal black line present on hind wing as on upperside, also on fore wing from the apex to the anal angle.

♀. Upperside.—Fore wing as in male. Hind wing bordered with brown from apex to the anal angle.

Underside as in male, except that the marginal line is replaced by a small black dot at the extremity of each nervule.

Head, thorax, and abdomen brown; antennæ brown; legs white, with black spots.

Expanse, ♂ $1\frac{1}{2}$, ♀ $1\frac{3}{10}$ inch.

Hab. W. Africa, Lagos.

This species, although somewhat allied to *S. epius*, Westw., on the underside, is distinguished, apart from its larger size, by the pure white wings. On the upperside the female of this species bears a close resemblance to *Larinopoda muhata*, Dewitz, as figured in 'Lepidoptera Exotica' by Mr. H. G. Smith.

6. *Spalgis pilos*, sp. n.

♀. Allied to *S. lemolea*, but the internal areas of both wings light straw-colour and the costal margin of the hind wing broadly bordered with brown from the base to the apex, where it joins the outer marginal border.

Expanse $1\frac{3}{10}$ inch.

Hab. W. Africa, Gambia.

This species can be at once distinguished from the preceding by the broad border to the costal margin, as described above.

I have no hesitation in placing these two species in the genus *Spalgis*, as they agree well in all generic characters with *S. epius*, Westw., notably the extremely short antennæ and the pointed fore wing in the male.

7. *Hypolycæna liara*, sp. n.

♂. Upperside.—Fore wing black, with the basal third suffused with light blue; an oval patch of thick, shining, light brown scales at the end of the cell. Hind wing black, suffused with light blue from the third median nervule to the inner margin: tails white, with black lines down the centres: a dark red spot bordered with black at the anal angle.

Underside whitish, with a transverse brown band common to both wings and a black marginal line. On hind wing a large black spot bordered inwardly with yellow between the first and second median nervules and a large crimson patch at the anal angle with a small black spot.

Head white; thorax and abdomen covered with bluish-white hairs; palpi black above, white below; antennæ and legs white, annulated with black.

When held at an angle this species exhibits the brilliant purple gloss common to the group, but more especially towards the anal angle of the hind wings.

Expanse $1\frac{2}{5}$ inch.

Hab. W. Africa, Addah, Lagos.

This species is distinguished by the light colour of the blue above. On the underside the markings are arranged as in *H. antifaunus*, Hew., but the tails appear much shorter and thinner. It has also the patch of scales on the fore wing above as in *H. naara*, Hew.

8. *Hypolycæna kadiskos*, sp. n.

♂. Upperside dull brownish purple. Hind wing with three indistinct black marginal spots, bordered inwardly with white, towards the anal angle; the inner margin brownish, clothed with white hairs.

Underside brownish white, with a brown band and markings arranged as in *H. hatita*, Hew.; but, in addition to these, a short distinct brown line at the end of the cell in the fore wing and a small brown spot on the costal margin near the base on hind wing; fringe white; tails considerably shorter than in *H. hatita*.

Head, thorax, and abdomen brownish; legs and antennæ whitish, annulated with black.

Expanse $1\frac{2}{5}$ inch.

Hab. W. Africa, Lagos.

This species, which somewhat resembles *H. Buxtoni* on the upperside, would appear to be intermediate between *H. hatita*, Hew., and *H. philippus*, Fabr., on the underside.

9. *Deudorix cœrulea*, sp. n.

♂. Upperside.—Fore wing glossy blue, with a darker patch at the end of the cell; the apical third and the costal margin blackish brown. Hind wing glossy blue, with the costal margin blackish brown and the inner margin greyish.

Underside light brown, with indistinct markings arranged as in *D. diyllus*, Hew., and a jet-black mark on the fore wing just above the centre of the submedian nervure. On the hind wing a black spot, bordered inwardly with yellow, between the first and second median nervules; lobe black, with yellow above; the tuft of hairs attached to the inner margin of the fore wing below is black.

♀. Upperside.—Fore wing dull light violaceous blue, the costa, apex, and outer margin broadly brown. Hind wing blue; costal margin and apex broadly, and outer margin narrowly, brown; lobe black, bordered above with yellow.

Underside as in male.

Head whitish; antennæ black, annulated with white; legs white, spotted in front with black.

Expanse, ♂ ♀ $1\frac{3}{10}$ inch.

Hab. W. Africa, Lagos.

On the underside this species is allied to *D. diyllus*, Hew., which also has the black mark as described above. Hewitson's figure (71) on pl. v. *b* of the Supplement to his Lycænidæ is almost unrecognizable. On the upperside it is distinguished by the much larger areas of blue, the blue of *D. diyllus* being of a greenish hue. The hairy tuft on the inner margin of the fore wing below is yellow in *D. diyllus*.

10. *Iolaus menas*, sp. n.

♂. Upperside.—Fore wing brilliant light blue, near *I. iasis*, Hew., in colour; apex and outer margin black, extending to the lower median nervule; costal margin narrowly black except at the base. Hind wing blue as above, the outer margin from the apex to the anal angle very narrowly bordered with black; a large triangular patch of thick black scales commencing just above the subcostal nervure and extending outwards along about one third of the first subcostal nervule and downwards to the blue; the costal margin shining greyish.

Underside.—Fore wings pure white. Hind wings much as in *I. iulus*, Hew.

♀. Upperside.—Fore wings pure white, with the costal margin, the apical third, and the outer margin blackish brown, which extends to the posterior angle; the base suffused with light blue, extending well into the wing. Hind wing pure white, with the apex blackish brown and a well-marked dark line extending from the apex to the inner margin just above the lobe; beyond this and close to the margin a row of blackish markings reaching from the apex to the second median nervule; the lobe brick-red, with a black spot and a few metallic blue scales; a large bright orange spot, bordered inwardly and outwardly with brown between the first and second median nervules, and another smaller orange spot between the submedian nervure and the first median nervule; suffused with blue at the base, but not to the extent of the fore wing.

Underside pure white, in some specimens a slight indication of an outer-marginal line to fore wing. Hind wing as in male, but the red spot between the first and second median lighter in colour.

Head white; thorax bluish; abdomen white; legs white; palpi white, tipped with black.

Expanse, ♂ $1\frac{4}{5}$, ♀ 2 inches.

Hab. W. Africa, Gambia.

The orange spot between the submedian nervure and the first median nervule on the hind wing of female above appears somewhat variable, as in some examples it is very small and in others replaced by a blackish mark. The female of this species bears a close resemblance to the female of *I. ismenias*, Klug (which is exactly like the male with the exception of the scaly patch on the hind wing at the base of the median nervules), from which it is distinguished by the well-marked inner line on the hind wing above, by the greater suffusion of blue at the base, and by the orange spot on the hind wing above being invariably bordered on the inner side with brown. In *I. ismenias* this spot is closer to the margin than in *I. menas.*

In a male of this species from the same place the black lines on the hind wing below have entirely disappeared and likewise the yellow spots on the hind wing of a female above.

11. *Iolaus lukabas*, sp. n.

♂. Allied to *I. iulus*, Hew., but without the greenish gloss.

Upperside.—Fore wing brilliant blue, with the costal margin and apical third black. Hind wing blue as above, with four distinct marginal spots of black placed between the nervules, commencing between the submedian nervure and the first median nervule and continuing upwards.

Underside pure white, with a trace of a short black line above the lobe only; a very minute brick-red spot between the first and second median nervules; lobe brick-red, with a large black spot on the outer edge; the tuft of hair which is attached to the margin of the fore wing below is yellow.

Expanse $1\frac{9}{10}$ inch.

Hab. W. Africa, Gambia.

This species is distinguished from *I. iulus* by the black-bordered costal margin and by being without the greenish gloss above, and by the absence of all lines on the underside.

12. *Iolaus paneperata*, sp. n.

♂. Upperside: allied to *I. lukabas*, but smaller; the costal margin bordered with black, as in that species.

Underside.—Fore wing white, with two almost invisible greyish lines running parallel with the outer margin. Hind wing as in *I. iulus*, Hew.; the tuft of hair on the inner margin below is black.

Expanse $1\frac{3}{5}$ inch.

Hab. W. Africa, Lagos.

This species can be distinguished from the preceding by its smaller size and by the difference in the colour of the tuft of hair attached to the margin of the underside of the fore wing.

13. *Iolaus iaspis*, sp. n.

♂. Allied to *I. iasis*, Hew. Upperside rather darker blue, with a brilliant greenish gloss; the shaped inner margin of the fore wing (which in *I. iasis* is edged with white) blue; the shining patch near the base on the hind wing black in place of greyish, smaller, and not margined with white; the anal angle black.

Underside.—Fore wings as in *I. iasis*. Hind wings with the space, which is contained between the black line over the lobe and the inner margin, orange-red, with an irregular line of silvery blue through the centre. In *I. iasis* the margin only is bordered from the lobe to the end of the black line.

Head pure white.

Expanse $1\frac{1}{5}$–$1\frac{2}{5}$ inch.

Hab. W. Africa, Addah.

Distinguished by the darker blue and the greenish gloss above and by the large patch of red at the anal angle below.

We have specimens of *I. iasis* also from Addah.

IV.—*Description of a new Species of* Crocidura *from the Amur Region.* By G. E. Dobson, M.A., F.R.S.

The species of *Crocidura* are generally as characteristic of the tropical and subtropical parts of the Eastern Hemisphere as those of the genus *Sorex* are of the temperate and subarctic regions. It is therefore interesting to record the discovery of a species of the first-named genus at so high a latitude as that through which the River Ussuri flows. The type of this species, which proves to have been hitherto undescribed, was found by me in the collection of the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg.

Crocidura lasiura.

Larger than *C. araneus* and differing from that species conspicuously in the much longer, denser, and darker coloured fur, which is almost the same on both surfaces, in the hairiness of the tail, which is well covered with short hairs from which long ones project, in the much larger size of the pes and manus, and in the remarkable elevation of the premaxillary bones. Whereas in *C. araneus* the anterior maxillary tooth exceeds the third incisor in cross section at the base, in this species the third incisor considerably exceeds that tooth in cross section viewed from without; and while in this species the anterior maxillary tooth is close to and slightly internal to the last premolar, in *C. araneus* it is separated by a narrow space. The anterior incisor has a well-developed posterior basal cusp, the tip of which is received into a well-marked depression in the anterior mandibular tooth. These are the characters of the teeth in the type, a still immature female. In a still younger female specimen, from Corea, in which the front upper incisor has not quite descended, the anterior mandibular tooth has the notch well defined, the tip of the anterior maxillary tooth is about equal in vertical extent to that of the anterior basal cusp of the last premolar, while the third incisor does not equal the anterior maxillary tooth in vertical extent.

× 7.

The ears are comparatively smaller than in *C. araneus* and the upper internal fold of the conch is very shallow.

Fur, as far as can be known from the examination of the specimen in alcohol, dark reddish brown on the upper surface, the extreme tips of the hairs beneath very faintly ashy. The tail is as densely covered with short fur, which forms a pencil at the extremity, as in average examples of *Sorex vulgaris*, of a dark brown colour, from which long, fine, greyish hairs project. The manus and pes are well covered with short brown hairs, some of which project beyond the claws. Ears more densely clothed with short hairs than in *C. araneus*.

No trace of a lateral gland, as, indeed, might be expected in a female specimen, especially in one not yet full-grown.

Length, head and body 65 millim., tail 32, eye from end of muzzle $12\frac{1}{2}$; ear, length 8; elbow to end of middle digit without claw $19\frac{1}{2}$; manus $8\frac{1}{2}$, pes $13\frac{1}{2}$; distance between tips of first upper incisor and last premolar 5.

The skull shows that the type is immature, for the basioccipital suture is still open, and as it exceeds the largest specimens of *C. araneus* in the length of the forearm, manus, and pes, full-grown specimens must be considerably larger.

Hab. Manchuria (Ussuri River, a tributary of the Amur), Corea (Fusan).

The above description of this, the most northerly species of the genus as yet known, is taken from the type, which is preserved in the collection of the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg, and from a specimen in the collection of the Royal Zoological Museum at Florence *.

V.—*Descriptions of new Pectinicorn Coleoptera.* By Charles O. Waterhouse.

Having recently been engaged in incorporating numerous accessions to the Pectinicorn Coleoptera in the British Museum, I have found several species which do not appear to be described and which I have made the subject of this paper, adding to them a most interesting species of the genus *Lucanus*, kindly lent to me for description by Mr. A. Fry.

Lucanidæ.

Lucaninæ.

Lucanus laminifer.

♂ *var. max.* Piceo-niger, æenescens, griseo-pubescens, nitidus. Mandibulis capite cum thorace duplo longioribus, antice fortiter deflexis, intus dentibus parvis numerosis, basi supra dente acuto introrsum directo armatis, apice incurvatis bifidis. Capite antice concavo, supra laminis tribus erectis ornato; clypeo acuminato, supra lamina transversa instructo. Thorace convexo, crebre subtiliter punctulato, lateribus medio leviter sinuatis. Elytris thorace latioribus, crebre subtiliter punctulatis. Femoribus rufo-maculatis. Tibiis anticis quinque-spinosis, apice bifurcatis; intermediis 3- vel 4-spinosis; posticis bispinosis.

Long. corp. 23 lin., mandib. 17 lin.

♂ *var. minor.* Mandibulis capite dimidio longioribus, arcuatis, ante apicem dentibus duobus armatis, apice furcatis. Capite antice lamina parum elevata instructo; clypeo lamina nulla; ceteris ut in *L. Westermanni.* Pedibus minus acute spinosis; femoribus obsolete maculatis.

Long. corp. 17 lin., mandib. 5 lin.

♀. Sat elongatus, angustus. Capite crebre rugoso. Thorace disco subtiliter parce punctulato, lateribus crebre sat fortiter punctatis, ante basin oblique excisis. Femoribus immaculatis; tibiis anticis obtuse dentatis.

Long. 15, lat. 6 lin.

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* See Giglioli and Salvadori, Proc. Zool. Soc. 1887, p. 581.

Hab. Assam, Munipur, 6000 feet (*Wm. Doherty, Esq.*). Coll. A. Fry.

This species is nearest to *L. maculifemoratus.* The largest form is quite unlike any other species, and the long deflexed mandibles somewhat resemble those of *Cladognathus inclinatus*, having on the inner side about eighteen or twenty small teeth, with a rather larger one at the middle. On the top of the head are three large erect laminæ, one in front, as in *L. maculifemoratus*, but larger and arched at the top, and two others (representing the usual posterior crest), wider than the anterior one, slightly oblique, arched at the top, with the outer angle produced.

The smaller male closely resembles *L. Westermanni*, but is distinguished by the mandibles having two teeth in front of the middle (instead of one) before the apical fork.

The female resembles that of *L. maculifemoratus* in its elongate narrow form, but is not quite so long, has the thorax more parallel at the middle of the sides, more strongly sinuate before the posterior angles, and with the disk almost smooth. The anterior tibiæ are nearly as in *L. maculifemoratus*, with three or four teeth besides the terminal one, and with the apex not very much produced.

I am indebted to Mr. Fry for the opportunity of describing this very interesting species.

Prosopocœlus Hanningtoni.

♂. Niger, subsurdus, thoracis disco elytrorumque sutura nitidis. Mandibulis capite paulo longioribus, intus tuberculis tribus distantibus instructis. Capite longitudine duplo latiore, antice lunato, pone oculos tuberculo parvo obtuso instructo; clypeo producto. Thorace transverso, subtiliter dense granuloso, lateribus fere parallelis, ante basin oblique fere recte truncatis. Elytris creberrime evidenter punctulatis.

Long. (mand. incl.) 18 lin., ♂ var. med.

♀. Niger, nitidus. Capite fortiter punctato. Thorace subtiliter punctulato, ad latera fortius punctato, lateribus antice et postice rotundatis. Elytris nitidis, subtiliter punctulatis, lateribus surdis, crebrius punctatis, punctis majoribus.

Long. 12 lin.

Hab. East Africa, Forests of Tiveta (*Bishop Hannington*).

This species is very near to *P. senegalensis*, but is broader and less convex; the head has the sides more parallel, the tubercle behind the eyes being more prominent; the surface behind the eye is more distinctly punctured. The epistome is produced into a tooth which is more prominent than in allied species. The mandibles are less flat than in *P. senegalensis*, with a small tubercle on the inner margin near the base; a larger one in the middle, and a third near the apex; and between this and the apex may be seen two very small tubercles. The thorax has the oblique part at the posterior angles almost straight, and not sinuate as in *P. senegalensis*. The elytra are very similar, but flatter and less narrowed at the base, moderately closely and distinctly punctured, but towards the sides the punctures are inconspicuous, on account of the very dull surface. The mentum is broader, more concave, and less punctured than in *P. senegalensis*.

Three specimens of this interesting species were received from the late lamented Bishop Hannington.

Metopodontus asteriscus, Th.

This species is considered in Parry's Catalogues of Lucanidæ as synonymous with *M. occipitalis*. In the British-Museum collection there are several female examples from Borneo which agree with M. Thomson's description of *M. asteriscus*, and they all differ from the female examples of *M. occipitalis* from the Philippine Islands in being less shining, and much more strongly punctured, and in having the black at the suture of the elytra narrower. If I am correct in identifying these Bornean specimens with *M. asteriscus*, there can be little doubt that it should be considered a distinct species from *M. occipitalis*.

Metopodontus Rœpstorffi.

Piceo-flavus, nitidus. Capitis lateribus, mandibulis plus minusve, thorace maculis tribus, elytrorumque sutura nigris. Corpore subtus pedibusque nigro ornatis.

♂ *var. min.* Long. (mand. incl.) 13 lin.
♀. Long. $11\frac{1}{2}$ lin.

Hab. Andaman Islands (*Rœpstorff*).

This is very close to *M. occipitalis*, but I think may well receive a distinctive name. The mandibles of the male are as long as the head, pluridentate. The head is rather narrow, semicircularly emarginate in front, rather straight at the sides, with a small tubercle behind the eye. Two oblique brown marks above indicate the ridges of the larger varieties. The thorax is densely granular and sparingly punctured, gently arcuate at the sides. The elytra are moderately closely and very distinctly punctured; the black at the suture is lanceolate in outline, very narrow towards the scutellum and at the extreme apex.

♀. This resembles the female of *M. occipitalis*, but is more strongly punctured throughout, the punctuation at the sides of the thorax (and especially at the anterior angles) being coarse and crowded together, whereas in *M. occipitalis* the punctures are separated from each other. The spot on the disk is large, and in one specimen extends from the base to the anterior margin. The elytra have the black at the suture very broad at the middle (about 2 lines in width), gradually narrowed to the scutellum and apex.

Dorcinæ.

Ægus Rœpstorffi.

Æ. acuminato affinis et similis. Piceo-niger.

♂ *var. max.* Sat nitidus. Mandibulis capite longioribus, arcuatis, depressiusculis, basi dente valido, medio dente parvo instructis. Capite thoraceque minus nitidis. Elytris fortiter punctato-striatis, interstitiis parce subtilissime punctulatis, marginibus rugoso-punctatis.

Long. (mand. incl.) $14\frac{1}{2}$ lin.

♂ *var. minor.* Mandibulis medio dente nullo. Capite thoraceque fortiter punctatis. Elytris interstitiis crebre sat fortiter punctatis.

Long. (mand. incl.) 8 lin.

♀. Capite thoraceque crebre fortiter rugoso-punctatis, hoc lateribus arcuatis, ante basin oblique sinuatis. Elytris striatis, interstitiis crebre fortiter seriatim punctatis; lateribus leviter arcuatis.

Long. 7–9 lin.

Hab. Andaman Islands (*Rœpstorff*).

This species is very similar to *Æ. acuminatus.* The large males may at once be distinguished by the position of the tooth at the middle of the inner margin of the mandibles. The punctures on the thorax are rather larger. The elytra have the striæ more strongly punctured, but the margin has only a narrow border of very strong punctuation. The smaller males with simple mandibles have the head and thorax more strongly punctured than the females of *Æ. acuminatus.*

Ægus Curtisii.

♂. Nigro-fuscus, parum nitidus, subtus rufo-piceus. Mandibulis capite paulo longioribus, ad apicem arcuatis, basi dente sat valido acuminato, medio supra dente minore instructis. Capite sat opaco, antice trisinuato, subtiliter sat crebre punctulato, genis pone oculos productis. Thorace brevi, sat opaco, subtiliter sat crebre punctulato, lateribus leviter bisinuatis, fulvo fimbriatis, angulis posticis late rotundatis. Elytris sat fortiter striatis, sat crebre subtiliter punctatis, striis obsolete punctatis, marginibus ferrugineo-tinctis, fulvo fimbriatis. Pedibus fulvo-testaceo-hirsutis.

Long. (mand. incl.) $10\frac{1}{2}$ lin.

Hab. Sumatra (*C. Curtis*).

This species might at first sight be supposed to be allied to *Æ. lævicollis* or *Æ. Eschscholtzi*, but in reality is nearest to *Æ. amictus*. The head and thorax have the punctuation very fine and uniform. The thorax has the sides at the anterior angles impressed. The punctuation of the elytra is fine, but not so fine as on the thorax; at the sides the punctures are rather stronger and crowded.

Ægus Parryi.

Piceus, nitidus.

♂ *var. max.* Capite magno, opaco; mandibulis capitis longitudine perpaulo brevioribus, intus prope basin dente valido angulato armatis. Thorace postice perpaulo angustato, discrete punctato, lateribus fulvo fimbriatis, angulis posticis oblique truncatis. Elytris striatis, striis obsolete punctatis, interstitiis 1^{o}–8^{m} lævibus, marginalibus parce punctulatis. Pedibus hirsutis.

Long. (mand. incl.) 8 lin.

♂ *var. min.* Capite minore, ad latera sat fortiter punctato. Mandibulis basi dente acuto armatis. Thorace sat fortiter punctato, lateribus medio fere parallelis.

Long. (mand. incl.) 4–$4\frac{1}{2}$ lin.

♀. Capite thoraceque sat fortiter punctatis, hoc lateribus arcuatis.

Long. 5 lin.

Hab. Borneo, Sarawak.

This species is very near *Æ. glaber*, but is distinguished from that and allied species by the sparse punctuation and smooth elytra, these latter being impunctate even in the female, except the two lateral interstices. The large males are remarkable for the size of the head. The largest male has the strong tooth at the base of the mandible angulated anteriorly, with a deep narrow incision in front of it. A rather smaller example has this tooth acuminate, with an emargination on the inner margin of the mandible in front of the tooth, and between this emargination and the apex the mandible is somewhat dilated.

Ægus Woodfordi.

Fusco-niger, sat nitidus.

♂ *var. minor?* Capite crebre fortiter punctato. Mandibulis sat depressis, capite vix longioribus, acuminatis, perpaulo arcuatis, basi intus dente brevi bilobo, medio tuberculo obtuso vix conspicuo armatis. Thorace capite paulo latiore, leviter convexo, crebre fortiter punctato (disco in medio lævi) antice parum angustato, angulis posticis oblique late rotundatis. Elytris leviter convexis, striatis, interstitiis sat crebre evidenter punctatis, basi lateribusque creberrime fortiter punctatis.

Long. (mand. incl.) 9 lin.

♀. Capite confertim fortiter punctato. Thorace antice paulo angustato, crebre fortiter punctato, lateribus vix arcuatis, serrulatis, confertim punctatis, angulis posticis oblique truncatis. Elytris basi thorace angustioribus, postice paulo ampliatis, convexis, tenuiter striatis, creberrime sat fortiter punctatis.

Long. $7\frac{1}{2}$ lin.

Hab. Solomon Islands, Alu (*C. M. Woodford, Esq.*).

This species is quite unlike any with which I am acquainted. The comparatively straight acuminate mandibles have a double short tooth at the base, with a trace of another at the middle. The elytra are striated, with the third and fifth interstices very narrow, distinctly and moderately closely punctured, more strongly punctured beyond the seventh stria, the base and the margins rugose. The margins are beset with very short hairs, which are slightly separated from each other.

Figulinæ.

Nigidius divergens.

Niger, nitidus. Capite antice leviter concavo, confertim punctato, oculorum canthis retrorsum directis, divergentibus, acutis. Thorace bene convexo, supra parce subtiliter punctato, ad latera sat fortiter punctato; margine antico fortiter impresso, creberrime rugoso punctato, linea brevi mediana elevata instructo; disco medio linea fortiter punctata impresso, ante medium utrinque fovea impresso; lateribus subparallelis, pone angulos anticos incisura parva. Elytris sulcatis, sulcis fortiter punctatis, interstitiis costiformibus lævibus.

Long. (mand. excl.) $10\frac{1}{2}$ lin.

Hab. Lake Nyassa (*Thelwall*).

Very near *N. bubalus.* The mandibles as in that species; very closely and coarsely punctured on the inner side of the erect horn, which has the tip turned in nearly at right angles and obtuse. The head is closely punctured with large punctures, with a smooth spot behind each mandible, and a dull bare patch on the vertex. The ocular canthus is large, acuminate, directed outwards and backwards; between the canthus and the base of the mandible are two nearly equal swellings in the margin. The thorax has the anterior border coarsely punctured, as in *N. bubalus*, but this border is much broader. The stronger punctuation at the sides does not extend on to the disk, so that it is not visible from above. There is a distinct small triangular emargination just behind the anterior angles. The sulci of the elytra have a series of rather large punctures, with a line of fine punctures on each side on the sides of the intervening costæ.

Nigidius Welwitschii.

Niger, nitidus. Capite creberrime punctato, lateribus antice parallelis, oculorum canthis arcuatis, postice acutis. Thorace transverso, disco antice subtrilobato, subtiliter parce punctulato, margine antico et impressione discoidali fortiter punctatis; lateribus fere parallelis, fortiter punctatis. Elytris sulcatis, sulcis fortiter punctatis, interstitiis lateralibus costiformibus.

Long. $5\frac{2}{3}$ lin.

Hab. Angola (*Welwitsch*).

The mandibles are rather small, closely punctured, with the horn short and curved. The head is coarsely and closely punctured, the sides in front nearly straight, with a slight dentiform projection just before the anterior angle; the canthus is arcuate, acute posteriorly. The thorax has the anterior part of the disk trilobate, the border strongly punctured; the sides straight, strongly angular before the posterior oblique truncature; rather strongly punctured, the punctures rather near together, crowded together near the front angles at a spot a little removed from the margin. The elytra are sulcate, the sulci strongly punctured, but the punctures in the first and second sulci are smaller; on each side of the median line of punctures there is a line of fine punctures. The first and second interstices are not much raised, the others are costiform.

This species is very near *N. nitidus*, Th., but has the head of a different form.

VI.—*Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland).*—No. X. By Prof. M'Intosh, M.D., LL.D., F.R.S., &c.

[Plate VIII.]

1. On Abnormal Hydromedusæ.
2. On the Occurrence of the Ctenophores throughout the Year.
3. On a Heteropod (*Atlanta*) in British Waters.

1. *On Abnormal Hydromedusæ.*

Two examples of abnormal Hydromedusæ having precisely similar structure were procured by the midwater-net in August 1886 in St. Andrews Bay. They occurred amidst swarms of *Thaumantias*, *Bougainvillia*, *Oceania*, *Stomobrachium*, *Cyanea*, *Aurelia*, *Pleurobrachia*, *Beroë*, and other forms. A brief description of these was communicated to the Birmingham Meeting of the British Association the same year *, it being pointed out that so far as specific characters were present they seemed to be abnormal forms of Forbes's *Thaumantias melanops*. The latter, however, was only half an inch in diameter, whereas both of the specimens described were about 5 inches in diameter.

These large examples (Plate VIII. fig. 1) were readily distinguished by the presence of a simple pale cross of the reproductive bands along the radial canals, the bands, moreover, meeting in the centre of the disk, which was devoid of a manubrium. The disk had the ordinary shape, viz. moderately convex dorsally, somewhat flattened ventrally, and presented no novelty in the microscopic structure of its hyaline tissue. The margin is surrounded by a closely arranged series of tentacles of considerable length, each tapering from base to apex, and furnished with a single small black pigment-speck at the base. The pigment-granules show no special differentiation. Within the bases of the tentacles is the velum.

The reproductive bands, *g*, begin a short distance within the margin, and extend along the radial canals right across the disk in each case, thus forming a conspicuous cross. Moreover, the uniformity of their diameter is one of the most characteristic features, no ordinary *Thaumantias* resembling them in this respect, the nearest perhaps being *Thaumantias pilosella*.

* Report Brit. Assoc. 1886, pp. 710, 711.

These bands are somewhat regularly folded or lobulated at the margin, and have a pale grey or dull whitish colour. The elements (probably male) were not much developed, the minute constituent cells being finely granular. The bands met in the centre of the disk, so that there was little room for doubt in regard to the absence of manubrium and mouth.

A similar condition to the foregoing was observed in *Tima Bairdii*, Johnst., one of those characteristic forms found long ago by Edward Forbes on the West Sands at St. Andrews, a locality which the pen and pencil of this genial naturalist would alone have made classic ground to the marine zoologist.

In the midwater-net of the 28th September a small example of *Tima Bairdii* measuring about $\frac{5}{8}$ inch across (Pl. VIII. fig. 2) presented an unusually flattened shape, from the absence of the large manubrium. Moreover, the radial canals, *r c*, with the reproductive bands, which had a minutely granular structure, closely approached each other in the centre of the disk, so that a small circular area only intervened. Careful investigation of the latter area showed that the hyaline ectoderm of the Medusa was continuous in this region, so that no trace of an aperture existed. The radial canals ceased at the margin of the area, one or two, indeed, having a slight expansion before terminating. This area, although solid, corresponded with the gastric region in connexion with the radial canals, and therefore in this respect differed from the preceding examples of *Thaumantias*.

In the case just narrated (*Tima Bairdii*) the specimen had by no means reached the average size of the period; but this need not be held as indicating that it was stunted from the abnormality of its alimentary apparatus. In the large *Thaumantias* first mentioned it is apparent that without a trace of manubrium or mouth the species had not only attained the ordinary limit of growth, but had largely exceeded it. So far as our experience goes, no other *Thaumantias* in British waters attains such dimensions, though the digestive apparatus exists in full perfection. The instance of the *Thaumantias* therefore is more remarkable than Mereschkowsky's, for in his small species (*Bougainvillia*) the abnormal specimens were "only a little exceeded in size by the normal adult individuals," that is to say, those without manubrium and mouth were somewhat less.

In his "Remarks on a Mode of Nutrition among the Hydromedusæ of the Russian seas" C. Mereschkowsky * gives an

* Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pp. 177–181, pl. xx. (1879).

account of certain forms of *Bougainvillia paradoxa* from the White Sea which were totally devoid of a manubrium, and this was the more readily noticed from the absence of the dark red coloration usually characterizing it. Careful search for the manubrium revealed no trace, the whole gastro-vascular system consisting of a circular and four radial canals, without stomachal dilatation or communication with the exterior. The endodermic cells of the canals showed active ciliary motion, but no food could reach them. These specimens, which had attained about half a centimetre, had therefore reached nearly (but not quite) full size without being nourished in the ordinary way. Another species belonging to the same genus was occasionally found in a similar condition, the four radial canals meeting without forming a stomachal cavity and the mouth being entirely absent.

Mereschkowsky considers it is clear that such Medusæ live, and increase in size from a minute embryo without digestive organs, and even apparently without nourishment. Yet the latter notion cannot be accepted, and after searching through all the possible means he comes to the conclusion that "the Medusa can nourish itself by means of its ectoderm by absorbing the organic material dissolved in the sea-water." He cites the case of certain sponges which nourish themselves upon organic matter dissolved in sea-water, and also by means of their ectoderm, and thinks it possible that the Medusa can dispense with its entoderm and yet live and attain nearly its normal size. The ectoderm therefore in such cases fulfils the function of the entoderm, *i. e.* extracts and assimilates the organic matter dissolved in sea-water. He never found solid particles on the surface of the Medusa, and he is of opinion we have really to do only with organic matter dissolved in sea-water.

The theory broached by Mereschkowsky is not altogether new, but has formerly been brought forward to explain the nourishment of marine animals. Thus the naturalists of the 'Porcupine' Expeditions of 1869 and 1870 held that the marine Rhizopoda, like the Entozoa, had the power of absorbing organic matter or "diffused protoplasm" in sea-water. Moreover there is this feature in common with the abnormal Medusæ, viz. that both are devoid of a mouth. The same views therefore would equally apply to both. As formerly shown*, the question indeed is a wide one, and the remarkable tenacity of life exhibited by certain marine animals confined in pure sea-water lends some countenance to the notion.

* Ann. & Mag. Nat. Hist. ser. 4, vol. ix. p. 1 (1872).

However, as a rule mouthless marine animals are provided with certain definite modes of sustenance other than the mere imbibition of sea-water. Thus larval fishes devoid of a mouth have a yolk-sac, and protoplasmic animals either surround the food-particles with their bodies or place themselves in actual contact with them. The Hydromedusæ are generally somewhat voracious forms, even the smallest attacking animals much larger and higher in the scale than themselves. It is possible therefore that such mouthless Medusæ may, by contracting the disk, fold themselves over prey of various kinds, and thus directly absorb nourishment through the ectoderm. They certainly show remarkable eagerness and mobility in feeding. No species is more conspicuous in this respect than *Lizzia octopunctata*, which will permit itself to be dragged behind a *Sagitta* with the umbrella everted rather than loosen its hold. Again, L. Agassiz has seen half an *Idyia* (*Beroë*) close over a small *Bolina* and digest it, the cut edges overlapping its prey *. He seemed to think, indeed, that mutilated Discophora fared better in confinement than entire specimens.

The foregoing condition (in which the Medusæ are deprived of mouth and stomach) is the opposite of that described by Arnold Lang in *Gastroblasta Raffaeli* †, in which there are several stomachs and a variable number of apparently irregular tentacles and radial canals. None showed a truly radial arrangement. Many presented undulations in the outline and were ellipsoidal, indicating that they were in a state of division. They had sprung from others by the same method, the division commencing in each case at the margin, and it is probable that from very small parts an entire Medusa may be developed. If these Medusæ possess radial larvæ like *Eucope*, and propagate themselves by successive right angular divisions, we necessarily get a series of apparently irregular stages such as those described.

2. *On the Occurrence of the Ctenophores throughout the Year.*

Louis Agassiz considered the Ctenophores in general as annual animals, laying their eggs in the water in the autumn and then dying, the young brood making its appearance in the spring. He watched them on the shores of Massachu-

* Contrib. Nat. Hist. United States, vol. iii. p. 173.

† Jenaische Zeitschr. vol. xix. (1866). For this reference I am indebted to Dr. Scharff, of the Museum of Science and Art, Dublin.

setts for twelve successive years, and invariably found that in the earlier part of the summer the majority were small and not yet filled with eggs, as they are later in the season. The largest specimens, he adds, are always seen during the last summer months, and all disappear after the autumnal gales.

On the eastern coast of Scotland the most abundant Ctenophore at the beginning of the year, that is in January, is *Pleurobrachia*, which frequents the lower parts of the water, as demonstrated by the use of surface-, midwater-, and bottom-nets. This to a certain extent had long been known, for it is more than thirty years since the late Prof. G. E. Day exhibited to his class at St. Andrews in December living specimens gathered on the West Sands by Miss Otté. Moreover, the presence of small as well as large examples in the nets indicates that the ranks are being gradually recruited as well as by-and-by supplanted by the younger forms. There is little evidence of a general destruction of the adult forms at a given period.

The irregularity in size of those procured in January in all probability arises from the length of time during which spawning is carried on. The species continues in great profusion in February, and free (pelagic) ova were not uncommon—similar features characterizing the southern waters, as at Sheerness-on-Sea *, at this time. In March it was as plentiful both in the midwater- and bottom-nets, though the majority of the examples were small, a few, however, reaching $\frac{3}{4}$ inch in long diameter. Many minute young abounded in the trawl-like bottom-net towards the end of the month.

Like the other pelagic Cœlenterates, *Pleurobrachia* became very prominent in the midwater-net in April; but the specimens were chiefly small. At the beginning of May the size of the hordes of small *Pleurobrachiæ* ranged from $\frac{1}{8}$ to $\frac{1}{2}$ inch in long diameter; but they were accompanied by many larger forms, the number of the latter showing an increase on the previous month, a condition in St. Andrews Bay that may, however, have been due to immigration from the offing. The larger forms were mature. The majority were captured by the midwater-net, so that they had frequented the deeper regions of the water.

In July ova, larvæ, and young of *Pleurobrachia* were common near the bottom of the water, and towards the middle of the month ova and larvæ appeared in the midwater-net and by-and-by at the surface, the diameter of the latter varying from 1 to 1·5 millim. In every haul of the midwater- and

* From observations kindly furnished by Mr. Shrubsole.

bottom-nets the species occurred, the larger being most plentiful in the former. Many ($\frac{3}{4}$ inch in diameter) seem to have shed their ova. Throughout August small examples from $\frac{1}{8}$ to $\frac{1}{2}$ inch were most abundant in the surface- and midwater-nets, while the free ova were in various stages, and many of the larvæ had only recently escaped. The very young forms presented the trumpet-like projection of the mouth, and with the ova were most plentiful in the bottom-nets. During September they swarmed in the surface- and midwater-nets, ranging from $\frac{1}{8}$ to $\frac{1}{2}$ inch in polar diameter, and they were accompanied by ova and larvæ. Only a few of the same size and some larvæ were captured at the bottom. The collections made in the midwater-net afforded a contrast with those obtained *e. g.* in midwinter, the great size and beauty of the species at the latter season being noteworthy. They became rare in the surface-net in October, but myriads, ranging from $\frac{1}{8}$ to $\frac{9}{16}$ inch, still frequented the midwater; while a few accompanied by ova and larvæ appeared in the bottom-nets. Only a very few *Pleurobrachiæ* were captured in the surface- and bottom-nets in November, but many of large size appeared in the midwater-net. In December they were found at the surface in considerable numbers from $\frac{5}{8}$ inch downwards along with ova; indeed, at no period of the year were finer examples obtained. They ranged from $\frac{5}{8}$ to $\frac{1}{6}$ inch. A few also occurred in the bottom-net. As the cold season advanced they had a tendency to seek the deeper parts of the water.

It is thus apparent that many of these Ctenophores (*Pleurobrachia*) spawn in summer and attain their maximum size the following year, the adults gradually disappearing after shedding their ova. At no period, however, is the water devoid of them, and throughout the greater part of the year small forms are mingled with the larger. In *Pleurobrachia*, therefore, as in certain fishes, the spawning-period is evidently extended, that is, some are early mature, others considerably later, so that great irregularity in size is found at any given period.

Large specimens ($3\frac{1}{2}$ inches) of *Beroë ovata*, Esch., occurred in midwater at the commencement of the year along with young, the former only being obtained in February. Very young forms, $\frac{3}{16}$ inch again, appeared in April, showing that some ova were probably shed late in autumn *. Examples of moderate size were occasionally captured in May, and, like *Pleurobrachia*, sometimes injured the postlarval fishes in the midwater-net. In June and July *Beroë* became more abundant

* At Naples the deposition of ova is given as from November till June (Mittheilungen Zool. Stat. Bd. viii. p. 390).

and reached the surface of the water towards the end of the latter month; but in this neighbourhood it seldom is seen in the enormous numbers characteristic of July in the Zetlandic area. Both young ($\frac{1}{4}$ inch) and adults in full maturity (4 inches) were procured in considerable numbers throughout August. The larger forms became less conspicuous in September and October, a distinct increase in size occurring during the latter month in the younger forms, which range from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. Large examples were observed in November in the deeper parts of the water, and some of moderate size in December. The species appears to spawn in July and August, and most of the adults would seem to perish in the autumn. *Beroë* is thus seldom absent from the neighbouring seas.

In a former number of this Journal* the occurrence of a third Ctenophore, *Lesueuria vitrea*, M.-Edwards, in great numbers in British waters was pointed out. Very little has been heard of it in European waters since Milne-Edwards first described it from the Mediterranean in 1841. This to some extent, however, appears to have arisen from confusion with other species. Thus that patient and keen observer, Sir John Graham Dalyell, whose merits can scarcely be too highly estimated, described and figured in 1848 † a form called *Beroë bilobata*, which he associated with the *Eucharis Tiedmanni* of Eschscholtz, thus correctly appreciating the relationship of a species apparently identical with the present (*Lesueuria vitrea*). He procured eight small specimens in August and two larger, $1\frac{1}{2}$ inch, in the same month and in February, probably in the Firth of Forth. Michael Sars, again, found it somewhat later (1856) off the Norwegian coast.

Young *Lesueuriæ*, $\frac{5}{8}$ inch in long diameter, appeared in April, while in May they occurred in great numbers, indeed forming the most conspicuous feature in the pelagic fauna. In June they were almost as numerous, ranging from $\frac{7}{16}$ inch or less upwards, and mainly frequenting midwater. *Lesueuria* was not quite so frequent in July, but occasionally occurred in multitudes, both large and small examples being present in the midwater-net, the latter specimens being a little over 2 inches. Many at this time showed ova measuring ·016 to ·0083 inch. In August the average size is larger than in the previous months, though the numbers are less. Few were procured in September and October, but in November and December they were occasionally captured from $\frac{5}{8}$ to $1\frac{1}{2}$ inch in diameter. The older forms appear to spawn in July and gradually die

* Ann. & Mag. Nat. Hist., December 1888.

† 'Rare and Remarkable Animals,' ii. p. 254, pl. liv. figs. 4, 5, 6.

off, leaving the young to develop during the winter. Young and adult forms, however, occur throughout the summer and autumn, so that the spawning-period is probably extended. The great development of the lateral lobes of the oral region causes a near approach to the *Mnemia* (*Bolina*) *norvegica* of M. Sars.

All the Ctenophores are thus found in greater or less abundance throughout the year, and do not appear suddenly as young specimens and disappear as suddenly as adults.

3. *On a Heteropod* (Atlanta) *in British Waters.*

Two years ago (May 1887) the capture of *Clione* in considerable numbers in St. Andrews Bay formed a feature of the season, and one which has not been repeated since, though last year the water was persistently examined from January to December. The frequent investigations of the Bay, however, in 1888 brought to light, amongst other things, a small transparent univalve, like a finely fashioned shell of glass, containing its inhabitant. It occurred in the midwater-net opposite the Maiden Rock on the 5th September, along with a very rich and varied fauna, including *Actinotrocha* and *Appendicularia*. The specimen measured about $\frac{1}{12}$ of an inch, and the aperture of the shell rather more than half this length. It was not detected until immersion in spirit had taken place.

In outline (Plate VIII. fig. 3) the form agrees generally with that of *Atlanta*, such as figured by Souleyet in his fine atlas *, in having a glassy, compressed, nautiloid shell, with a narrow aperture and a prominent lip, which projects considerably beyond the posterior coil. In a lateral view, indeed, the aperture has a prominent and somewhat hooked prow (on the left in the figure), from which a double curve proceeds to the inner border. Two volutions and an incomplete third seem to be present.

When examined on edge (Plate VIII. fig. 4) the peculiarly compressed condition of the shell is evident, the widest part being at the posterior border of the lip, where it bends down to join the spire. So far as can be judged from the outline in this position, the posterior or whorled region of the shell is flatter than the anterior. Moreover the free edge of the shell is not keeled, as in so many of the foreign species, a flattened margin being present all round. It must be borne in mind, however, that this is probably a young example and that considerable changes may ensue during growth.

* Voyage autour du monde &c. sur la corvette 'La Bonite.'

The contracted and opaque condition in spirit prevents a satisfactory examination of the soft parts, but, as indicated in the outline (Plate VIII. fig. 3), three regions occur anteriorly. These probably correspond to the head, the fin, and the posterior division of the foot.

The occurrence apparently of an example of a group of mollusks formerly unknown in British seas is noteworthy. Hitherto they have been considered characteristic of the pelagic fauna of the more genial oceans, such as the Mediterranean and the warmer parts of the Atlantic and Pacific. All recent investigations however, tend to enlarge the area of truly pelagic types, and to raise the question whether temperature alone is the cause of the appearance and disappearance of such forms in our seas. It is true temperature appears to have a marked effect on the vertical distribution of certain types and the pelagic ova of fishes ; but in the case under consideration the influence of currents is probably of greater importance.

EXPLANATION OF PLATE VIII.

Fig. 1. Abnormal *Thaumantias,* devoid of manubrium and mouth. The reproductive bands meet in the centre. About natural size.

Fig. 2. Mouthless example of *Tima Bairdii,* the central region being imperforate.

Fig. 3. Lateral view of *Atlanta* from St. Andrews. × 31.

Fig. 4. View of the same on edge. The opaque central region is the mass formed by the contracted body of the mollusk. Similarly enlarged.

VII.—*Descriptions of new Species of Longicornia from India and Ceylon.* By Charles J. Gahan, M.A., Assistant, Zoological Department, British Museum.

[Plate VII.]

The present paper is in great part the result of my work upon a small collection of Longicornia made by G. F. Hampson, Esq., in the Nilghiri Hills, S. India, and kindly placed by that gentleman at the disposal of the British Museum. In the descriptions, however, I have not confined myself to species from the Nilghiris, but have included also species from other parts of India and Ceylon which had already existed unnamed in the British Museum collection.

Prionidæ.

Rhaphipodus subopacus, n. sp.

Capite prothoraceque nigro-fuscis ; elytris fusco-brunneis, subopacis,

minutissime et densissime granulatis, circum scutellum lævioribus, subnitidis; antennis dimidium elytrorum paullo excedentibus, scapo crasso, valde et subscabroso punctato, quam articulus tertius fere duplo longiore.
Long. 37, lat. 14 mm., ♀.

Hab. Nilghiri Hills (*Hampson*).

Head and prothorax nearly black; elytra and underside of body dark brown. Prothorax finely and very closely punctulate, with three nearly impunctate shining spaces on the surface of the pronotum (one on each side near the middle of the disk, the third narrow, transverse, basal) and with a small nitid spot on each side external to the discal spaces; with the lateral borders subparallel, not rounded anteriorly, and each provided with a row of small spines, of which that at the posterior angle is strongest and recurved; the obliquity of the margin from this spine to the base also with two or three small spines. Scutellum densely punctulate, with its posterior border smooth and subnitid. Elytra somewhat smooth and shining around the scutellum and on the anterior sutural region, with the rest of their surface dull, owing to its extremely fine and close granulation. Abdomen and sides of breast very finely and closely punctulate, with the posterior borders of the first four abdominal segments impunctate and very glossy, and with a triangular space of the metasternum subnitid and very sparsely punctulate. Legs blackish, with the tarsi reddish castaneous. Antennæ with the scape much stouter than and nearly twice as long as the third joint.

This species somewhat resembles *R. manillæ*, Newm., but is to be easily distinguished by the opacity of the elytra as well as by the greater relative thickness of the scape of the antennæ.

A single female specimen in the collection.

The following fine new species from Ceylon has up to now remained undescribed. There are three specimens in the Museum collection.

Rhaphipodus taprobanicus, n. sp.

♂. Fuscus; elytris castaneis, subopacis; prothorace minutissime et creberrime punctulato, cum plagis et maculis disco nitidis et sparsim punctatis, marginibus lateralibus crenulatis, antice rotundatis; elytris minutissime et densissime granulosis, basi prope suturam lævioribus, subnitidis, sparsim punctulatis; antennis dimidium elytrorum excedentibus.

♀. Pronoto in medio nitido, tenuissime et sparsissime punctulato, versus latera valde et dense punctato; antennis dimidium elytrorum nec attingentibus.

Long. 60 mm.

Of the same general form as *R. manillæ*, Newm., but much larger, lighter in colour, with well-defined shining spaces on the surface of the pronotum, of which two, trigonous in form, are placed near the middle; the third, shaped somewhat like a bracket (thus ⏞), is placed transversely at the base; with the elytra dull, owing to the extremely small and close granulations, which cover all their surface except a space around the scutellum and along the suture; this space somewhat glossy and sparsely punctulate.

The female differs from the male not only by the different punctuation of its pronotum and the length of its antennæ, but by the sparse punctulation of its prosternum and by the metasternum exhibiting no marked limitation of a triangular smooth space. The last segment of the abdomen in the female is narrower and truncate at the apex; in the male this segment is broader and rounded at the apex.

The third specimen, a small male of about 48 millim. in length, is much lighter in colour than the other two and has fewer spines on the sides of the prothorax.

Prinobius æneipennis, Waterh.

Prinobius æneipennis, Waterh. (*Macrotoma*), Trans. Ent. Soc. 1881, p. 428.

This well-marked species was described by Mr. Waterhouse from a single male specimen. Mr. Hampson has captured a female, of which the characters compared with the male are:—

Size much greater (length 57 millim., width 18 millim.); antennæ smooth, sparsely punctured, not surpassing the middle of the elytra; pronotum nitid, sparsely and feebly punctured on the middle of the disk, strongly though sparingly punctured towards the sides, its lateral margins provided each with a row of small spines, of which that at the posterior angle is recurved and much longer than the rest; prosternum nitid, feebly and very sparsely punctured; sides of breast sparingly and feebly punctured and with a very sparse fulvous pubescence; legs less scabrous.

The genus *Prinobius*, Muls., put as a synonym of *Macro-*

toma by Thomson and Lacordaire, has been restored and recharacterized by Van Lansberge (Notes Leyden Mus. vol. vi.).

Cerambycidæ.

Plocœderus obesus, n. sp.

Hammaticherus obesus, Dup. Dej. Cat. p. 347.
Cerambyx obesus, Cat. Gemm. and Harold, p. 2802.

I do not find that this species has yet been described. It is wrongly placed in the Munich Catalogue, and should be put in the genus *Plocœderus*. Closely allied to *P. ferrugineus*, Linn., it differs by the following characters :—

With a pale castaneous derm, closely covered by a short fulvous-grey pubescence, which more or less hides the colour beneath ; with the joints of the antennæ narrowly tipped with black at their apices, and with a narrow line along the suture and the extreme margins of the elytra also black.

The specimens in the Museum collection are from N. India (Darjeeling and Siwalik Hills), Siam, and the Andaman Islands.

Plocœderus ferrugineus, Linn.

Cerambyx ferrugineus, Linn. Syst. Nat. 12th edit. p. 626 ; Oliv. Ent. iv. no. 67, p. 9, pl. xviii. fig. 134, *a* and *b* ; Fabr. Ent. Syst. i. pt. ii. p. 256.
Cerambyx gigas, Fabr. Mant. Insect. i. p. 132.

This Linnean species, whose name seems to have been altogether omitted from the Munich Catalogue, has for a synonym *P. nitidus*, White (*Hammaticherus*). The following manuscript note by Mr. White occurs in a copy of his 'Catalogue of B. M. Longicornia' :—"*Hammaticherus ferrugineus*, Linn., Oliv. . . . Near *nitidus*, larger, but may be the same." I have no doubt, having consulted Olivier's figure and description, that the two names refer to the same species.

Plocœderus versutus, Pasc. (*Cerambyx*), the type of which is in the British Museum collection, is very closely allied to, and is probably only a small variety of, *P. ferrugineus*.

The specimens of *ferrugineus* in the Museum collection are nearly all ticketed "Ceylon," two are ticketed vaguely "Ind. orient.," while one is ticketed (doubtless by mistake) "China."

A variety of *P. ferrugineus*, differing only in the colour of the elytra, which is almost black, occurs in N. India (Bengal).

This variety bears the manuscript name *Plocœderus niger*, Chevr.

Pachydissus similis, n. sp.

Hab. India and Ceylon.

This species is formed for the reception of individuals having so close a resemblance to *P. indutus*, Newm., that it would be impossible to distinguish them by merely examining them from above. On looking at the underside of the head a transverse groove is seen to cross it from cheek to cheek; in *P. similis* this groove is either perfectly straight, or, if at all curved, has the curvature directed slightly forwards; in *P. indutus* the groove is somewhat deeper and is strongly enough bowed backwards. I can find no other character of any value for distinguishing the two species, and should not have attributed so much importance to the character of the intergenal groove had I found both forms occurring indiscriminately in specimens from the same locality. But having picked out all the specimens, seventeen in number, with a straight intergenal groove, I found that they were without exception either from India or Ceylon; those specimens, on the other hand, with a backwardly bowed groove were from some one of the following localities:—Philippine Islands, Siam, Sumatra, Java, Borneo, or other island of the Malay Archipelago. One specimen was ticketed Ceylon and one Hong Kong.

Xoanodera regularis, n. sp.

Nigro-fusca; flavo-cinereo-pubescens; prothorace supra subnudo; disco longitudinaliter et regulariter costato; elytris pube flavo-cinerea dense obtectis, singulisque plaga laterali nuda, nigro-fusca, valde punctata.

Long. 21, lat. 6 mm.

Hab. N. India and Burmah.

Head with a somewhat sparse tawny pubescence. Prothorax rather sparsely pubescent above, thickly enough pubescent at the sides; the disk with four or more straight and well-marked longitudinal ridges. Scutellum and elytra with a close yellowish-grey pubescence; with a dark brown, strongly and reticulately punctured, nude space at the side of each elytron between the base and the middle, and with a small nude spot less strongly punctured on each side of the scutellum. The apices of the elytra obliquely truncate, with the angles shortly dentate. Legs and underside of the body with a uniform yellowish-grey pubescence. Antennæ in the female not quite so long as the body, blackish brown, with a greyish pubescence.

This species presents the preapical carina of the elytra and the carination of the femora which are characteristic of the genus. It may be distinguished from *X. amœna*, Pasc., which it most nearly resembles, by the darker colour of its derm and by the regular and very distinct longitudinal ridges on the disk of the prothorax. In one specimen, from Tavoy, Burmah, belonging to the collection of Alexander Fry, Esq., there are only four perfectly straight longitudinal ridges on the prothorax, those external to them being more or less wavy; in the specimen from N. India which I have selected as the type there are six perfectly straight ridges, while external to these there are on each side two others which are nearly straight. In *X. amœna* (the type of which, through Mr. Pascoe's kindness, I have been enabled to see) the ridges of the prothorax are not so strong and are all more or less irregular. Two specimens from the Nilghiris agree with Mr. Pascoe's type in this respect.

Gnatholea simplex, n. sp.

Omnino brunneo-griseo-pubescens, absque maculis eburneis.

Hab. N. India (Darjeeling).

With a rather close brownish-grey pubescence. Legs and antennæ with a similarly coloured but fainter pubescence. Elytra with a few scattered somewhat asperate punctures. Prothorax with two rather feeble tubercles placed a little in front of the middle of the disk.

This species has the characteristic mandibles of the genus and agrees generally with *G. stigmatipennis*, White, and *G. eburifera*, Thoms. It wants the ivory spots of the elytra met with in other species, and the elytra present fewer and smaller punctures than in the two species just mentioned.

Nyphasia fuscipennis, n. sp.

Rufo-fulvescens; antennis pedibusque (femorum petiolis exceptis) piceo-fuscis; elytris violaceo-fuscis, opacis, sat dense punctulatis.

Hab. Bombay.

Head, prothorax, scutellum, body underneath, and stalks of the femora reddish fulvous. Prothorax rounded or somewhat obtusely tubercled on the sides, closely punctured above and somewhat flattened on the disk. Elytra densely enough and finely punctured, dark brown, tinted with violet, the colour changing slightly in different lights; prolonged somewhat at the base on each side of the scutellum, and each provided with a small tubercle at the extreme margin of the base. Intercoxal process of the abdomen somewhat obtusely pointed in front.

This species fits into Lacordaire's second section of the genus; and had that author not described the elytra as "saturate prasinis" I should have been inclined to regard it as his *Nyphasia Pascoei*. His description leads me to believe that the elytra are more closely punctured in his species, which, moreover, is from a different locality, viz. Siam, and no mention is made by him of tubercles at the basal margin of the elytra.

Xylotrechus Hampsoni, n. sp. (Pl. VII. fig. 1.)

Rufo-testaceus; capite longitudinaliter sulcato, obsolete carinato; prothorace fasciis tribus sulphureis, fasciis anticis mediisque interruptis; elytris fasciis quatuor sulphureis—fascia antica lineata obliqua, fascia secunda triangulari, fasciis duabus posticis transversis—apicibus truncatis, angulis externis dentatis; corpore subtus sulphureo-fasciato; antennis dimidio basali rufo, dimidio apicali fusco.

Long. 15, lat. $4\frac{1}{2}$ mm.

Hab. Nilghiri Hills.

Head with a median longitudinal groove extending from the clypeus to near the occiput, with the sides of the groove scarcely raised; with a short carina on each side of the front just over the insertion of the antennæ. Prothorax with three sulphur-yellow transverse bands, the first a little behind the anterior border and slightly interrupted in the middle, the second just behind the middle and made up of four spots, the third on the basal border and at the sides united with a short longitudinal spot; with the space between the intermediate and basal yellow bands dull black and sparsely and minutely granulate. Elytra with an oblique black band on each side near the base, these bands meeting at the suture and thence produced forwards and spreading out a little on each side of the scutellum; with a narrow sulphur-yellow fascia occupying the middle of each of the black fasciæ and stopping short before reaching the suture; with a broad sulphur-yellow fascia somewhat in the form of a triangle a little in front of the middle of the elytra; with two transverse yellow fasciæ behind the middle, of which the posterior is less distinct than the anterior. Legs reddish ferruginous, with the intermediate and posterior femora somewhat infuscate at the middle; with the first joint of the posterior tarsus not quite twice as long as the two succeeding joints combined. Antennæ with the first five joints reddish, the remaining joints brownish black.

I have named this pretty insect after Mr. Hampson, to whose liberality the British Museum is indebted for it.

Lamiidæ.

Pharsalia proxima, n. sp.

Griseo-fulvo et fusco varia; prothorace supra leviter inæquali nec tuberculato, fulvo-griseo cum maculis duabus nigris; elytris prope basin valde tuberculatis, singulis lateraliter cum plaga obliqua alba.

Long. 21, lat. $7\frac{1}{2}$ mm.

Hab. Ceylon.

With a somewhat mixed pubescence of tawny grey and dark brown, with the former predominating on the upperside of the head and prothorax, with two velvety black spots on the middle of the disk of the prothorax. Elytra with an oblique white patch near the middle of each side, and each, at a short distance from the base, with a large obtuse tubercle which passes behind into a feebly raised line extending to near the apex. On the basal part the elytra are granulose and strongly punctured, the punctures posteriorly becoming much smaller. Prosternal process laterally and rather strongly dilated near the middle of its length. Mesosternal process produced in front into an acute conical tubercle.

This species rather closely resembles *P. gibbifera*, Guér., and in structural characters is more nearly allied to it than is any other described species of the genus. It is at once distinguished from it, however, by the absence of tubercles from the disk of the prothorax and by the much more acute tuberculation of the mesosternal process.

Batocera Polli, n. sp. (Pl. VII. fig. 2.)

♀. Nigra; cinereo-griseo-pubescens; prothorace antice et postice distincte bisulcato, supra trituberculato, disco maculis duabus luteis ornato; elytris basi dense et valde granulatis, deinde sparsim punctatis, maculis duodecim majoribus et tribus vel quatuor minoribus albo-tomentosis ornatis, apice sinuato-truncatis, angulis suturalibus dentatis; antennis fere muticis.

Long. 45, lat. 16 mm.

Hab. Ceylon.

Black; with a thin ashy grey pubescence above and a denser and somewhat darker pubescence underneath. Prothorax with four distinct transverse grooves—two anteriorly and two posteriorly; with two large tomentose luteous spots, which, united anteriorly, are separated behind by a smooth, glossy, rounded, and little raised tubercle occupying the middle of the disk; with a smaller, somewhat flattened, dull black tubercle at the antero-lateral angle of each spot. Scutellum with a white tomentum. Elytra each with six large and one or two very small tomentose white spots; the base covered with large and closely crowded granulations, which extend along the middle of the disk to less than a fourth of the length of the elytra and along the sides to nearly half their length; the shoulders each armed with a small and rather blunt tooth; the apices of the elytra somewhat sinuately truncate, rounded externally, dentate at the suture. Pubescence of the elytra denser along a broad sutural and marginal band. Body underneath with a broad white band on each side, which extends uninterruptedly from behind the eye up to the middle of the last abdominal segment. Antennæ black, with the first four joints smooth, glossy, and having traces of a faint greyish pubescence; with the remaining joints dull brownish black.

This very distinct species I have pleasure in naming after Mr. Neervoort van de Poll, to whom I am indebted not only for aid derived from his published contributions to the subject of the genus *Batocera*, but also for personal help in determining the species of this genus in the British Museum collection.

Cacia signata, n. sp.

Cinereo-pubescens; prothorace supra utrinque nigro-bivittato; elytris nigro-maculatis et pone medium nigro-subfasciatis.

Long. 14 mm.

Hab. Ceylon.

With an ashy pubescence. Prothorax above with two dull black vittæ on each side, with these vittæ slightly irregular in outline and for part of their extent united. Elytra with a small black spot on each side of the scutellum, a spot on each a little behind the middle of the base, a large plagiate spot on each side below the shoulder, with a common sutural spot just in front of the middle, this spot connected behind with a kind of zigzag black fascia, formed by a couple of irregular spots on each elytron; with two black spots on each near the apex. Body underneath ashy pubescent, with glabrous glossy spots along the middle; with an opaque black spot at each of the antero-lateral angles of the last four abdominal segments. Legs ashy pubescent, with the third and fourth joints of all the tarsi black, with the apices of the tibiæ infuscate, and with a rounded black spot on the anterior side of each of the posterior femora. Antennæ with the scape, second joint, and basal halves of the third and fourth joints ashy, the remaining joints dark brown, very narrowly ringed with grey; all ciliate underneath, with the ciliations denser below the dark and slightly thickened apical halves of the third and fourth joints. Pro- and mesosterna with their opposed faces vertical.

Two specimens in the Museum collection agree in the characters just given; a third specimen presents differences which may perhaps be regarded as varietal. In this specimen the two vittæ on each side of the prothorax are very regular in form and are separated throughout their whole length; on the elytra the antero-lateral spot is smaller and the common sutural spot is altogether wanting.

Coptops quadrimaculata, n. sp. (Pl. VII. fig. 3.)

Brunneo, griseo fulvoque variegata; elytris utrinque maculis duabus nigro-velutinis—altera ante, altera pone medium.

Long. 11–15 mm.

Hab. Nilghiri Hills (*Hampson*).

Head almost impunctate; prothorax and elytra with a few scattered punctures; prothorax with a single small dentiform tubercle on each side close to the anterior border. Elytra each with two velvety black spots, of which one, larger and transverse, is placed in front of the middle and nearly reaches the external margin, the other, smaller and rounded or irregular in form, is behind the middle and occupies a position nearly midway between the suture and external margin; all the spots have a more or less distinct narrow border of fulvous. On each elytron between the spots is a greyish patch. On the legs and underside of the body a fulvous-grey colour predominates, the brown being mostly confined to minute rounded spots. The scape of the antennæ is fulvous grey, speckled with brown; the joints from the third are fuscous, ringed with grey at the base.

This species has much the appearance of a *Mesosa*; but as the head is scarcely concave between the antennal tubercles and the prothorax is provided with a small antero-lateral tubercle, it seems to fit better into the genus *Coptops*. The prosternal process is truncate and vertical behind; and in this respect the species differs slightly from the more typical species of both *Coptops* and *Mesosa*. Its nearest ally seems to be an undescribed species from Java (*Anancylus binotatus*, Chevr., MS.).

Thylactus simulans, n. sp.

Xylorrhizæ adustæ simillimus, sed differt prothoracis lateribus spinosis; antennarum articulis a quarto ad decimum apicibus intus acute angulatis.

Hab. N. India (Darjeeling).

Clothed with a thick silky pubescence of a dark brown colour varied with pale fulvous yellow. On the elytra the brown is predominant at the base, the pale yellow at the sides, while posteriorly the colours are so mixed as to present a streaked appearance. Head with prominent antennal tubercles, with the brow between them broadly enough and strongly concave. Prothorax with a strong and rather obtuse spine on the middle of each side, with a paler yellowish line along the middle of the disk, on each side of which some strong punctures are visible. Elytra strongly and sparsely punctured near the base, with the punctures almost concealed by the pubescence; rounded externally at the apex, with each at the suture prolonged into a broad blunt process. Legs short and stout, with the tarsi about equal in length to the tibiæ. Antennæ (♀?) reaching to about two thirds the length of the elytra, with the scape and third joint somewhat thickened at their apices; with each joint from the fourth distinctly angular on the inner side at its apex.

In its size, colour, and style of marking this species bears a remarkable resemblance to *Xylorrhiza adusta*, Wied., but its characters show it to be generically distinct. Unless a special genus is to be formed for its reception, I do not see that it can be better placed than in the genus *Thylactus* of Pascoe. The form of its elytra at the apex is unusual for this genus and agrees closely enough with that of *X. adusta*.

There is but one specimen in the British Museum collection.

The following species, also from N. India, agrees better with the characters of *Thylactus*, and has the general form of *T. longipennis*, Pasc.

Thylactus dorsalis, n. sp. (Pl. VII. fig. 4.)

Albo-flavescente dense pubescens; capitis fronte nigra, sparsim pubescente et valde punctata; prothorace supra plagis duabus nigris vix pubescentibus et valde rugoso-punctatis; elytris dorso juxta suturam late nigrescentibus, apicibus lateraliter dilatatis, postice valde emarginatis.

Long. 28–30, lat. 8 mm.

Hab. Nepal (*General Hardwicke*).

Front of the head black, sparsely pubescent and strongly punctured; vertex and antennal tubercles with a thick yellowish-white pubescence, with the pubescence so arranged on the latter as to make them appear very prominent and pointed. Prothorax strongly spined at the sides, with a yellowish-white pubescence, with, on the disk, two scarcely pubescent blackish spaces, which are seen to be strongly and rugosely punctured. Elytra with a yellowish-white pubescence; with a broad, somewhat irregular, blackish space along the suture, not continued to the apex; with a broad and rather faint longitudinal depression on each side below the disk, and near the posterior extremity of each of these depressions with two or three feeble cariniform tubercles, which are covered over by the pubescence; each elytron deeply emarginated at the apex, so as to leave a narrow blunt process on the sutural side of the emargination and an obtuse, externally rounded, dilatation on the outer side. Underside of the body and the legs with a yellowish-white pubescence mixed on parts with brown; the abdomen with some scattered, small, shining black spots. Antennæ with the joints from the third dark brown, ringed with grey at their bases.

Rhodopis piperata, n. sp.

R. puberæ similis, differt prothoracis lateribus distincte et valde spinosis; elytris utrinque ad medium basis tuberculatis.

Long. 14-16, lat. 5 mm.

Hab. Nilghiri Hills (*Hampson*).

Head somewhat narrowly and triangularly concave between the antennal tubercles, front and vertex sparsely punctured and clothed with a pubescence which is partly greyish and partly fulvous. Prothorax strongly and rather sparsely punctured above, with a faint greyish pubescence and with three narrow, longitudinal, tawny vittæ; with a distinct and rather strong spine on each side, which is directed very slightly upwards. Elytra with a rather mottled pubescence of grey, tawny, and dark brown; with a tubercle, surmounted by a few small shiny granules, on each side of the scutellum; basal half of elytra sparsely punctured, the punctures disappearing or becoming concealed beyond the middle; apices of elytra truncate. Body underneath with a greyish pubescence, with some spots at the sides of the thorax and the posterior borders of the abdominal segments fulvous; sides of the metasternum and of a few of the abdominal segments with some small, rounded, denuded black spots. Legs grey, with the tarsi and apices of the tibiæ black. Antennæ with the scape gradually and slightly thickened towards the apex, with the joints from the third ashy towards their bases, and for the rest of their length black; third joint in the male strongly and abruptly clavate towards its apex.

Rhodopis alboplagiata, n. sp. (Pl. VII. fig. 5.)

Griseo-pubescens; antennis scapo et articulo tertio ad apicem (♂) clavatis; prothorace lateribus valde spinosis, dorso fulvo-trivittato; scutello fulvo; elytris brunnescenti-pubescentibus, ad basin et juxta suturam griseis, singulisque plagis duabus dilaceratis albis —altera ante, altera pone medium, apicibus subtruncatis vel rotundatis; corpore subtus pedibusque subtiliter griseo-pubescentibus.

Long. 15½, lat. 5½ mm.

Hab. N. India (Darjeeling).

Head, prothorax, and base of the elytra sparsely punctured. Prothorax strongly enough spined at the sides, with the spines directed somewhat obliquely upwards. With the scape of the antennæ clavate, with the third joint in the male abruptly clavate at the apex, with the antennæ themselves rather widely separated at the base. With the first joint of the posterior tarsus as long as or slightly longer than the two succeeding joints combined.

Rhodopis albomaculata, n. sp.

Antennis scapo et articulo tertio ad apicem (♂) clavatis; prothorace lateribus valde spinosis, dorso fulvo-trivittato; scutello fulvo; elytris fulvo-griseo-pubescentibus fusco mixtis, cum maculis nonnullis parvis, albo-tomentosis; corpore subtus pedibusque fulvo-griseo-pubescentibus.

Long. 16–19, lat. 5½–6¼ mm.

Hab. N. India (Darjeeling, Nepal).

Head, prothorax, and basal third of the elytra sparsely punctured. Antennæ with the scape clavate and the third joint in the male abruptly clavate at the apex. Prothorax with a greyish pubescence above and with three fulvous lines along the disk; acutely spined on each side, with the spines directed obliquely upwards. Elytra with some small whitish spots, which are not very regular in number or position, but with usually a group of three on the disk of each in front of the middle, and two more distinct and close together behind the middle. Apices of the elytra somewhat obliquely truncate. Posterior tarsi with the first joint as long as the two succeeding joints combined.

This and the preceding species, while not differing sufficiently to be formed into a genus apart, will form a section in the genus, characterized by the clavate scape of the antennæ and the longer first joint of the posterior tarsus.

Cylindrepomus virgatus (Melly, MS.), n. sp.

Supra niger, longitudinaliter cinereo-vittatus; capitis vertice vittis duabus antice conjunctis postice divergentibus; prothoracis dorso vittis tribus; elytris singulis vittis tribus, vitta mediana ad medium interrupta; apicibus elytrorum suboblique truncatis; corpore subtus cinereo-pubescente cum linea pectoris et maculis ad latera abdominis nigris; antennis pedibusque nigrescentibus, scapo antice scabroso.

Long. 15, lat. $3\frac{1}{2}$ mm.

Hab. Himalayas.

With deep black and ashy, alternating, very distinctly vittate; with two ashy and three black vittæ on the upperside of the head; with three ashy and four black vittæ on the upperside of the prothorax, and a broad ashy vitta on each side low down. Elytra each with three ashy and four black vittæ, including the black sutural line and the narrow black border externally; with the ashy vittæ all united at the apex, and with the two intermediate black vittæ connected by a transverse bar at the middle of their length. The elytra along the black vittæ seen to be thickly enough and rather strongly punctured. Elytra somewhat abruptly narrowed posteriorly, with a subsinuate and slightly oblique truncature at the apex.

Sthenias albicollis, n. sp. (Pl. VII. fig. 6.)

Parvus in hoc genere, griseo-brunneo-pubescens cum prothorace lateraliter et plaga postica singuli elytri albescentibus.

Long. 10–13, lat. 3–4 mm. (♂ ♀).

Hab. Nilghiri Hills, S. India (*Hampson*).

Rather small and narrow for this genus. Prothorax whitish at the sides and greyish white along the middle of the disk; with a few very small black spots, of which one at the middle of the base and two near the middle of the disk are more distinct. Scutellum fulvous, and, in the middle, grey. Elytra greyish brown, with an oblique whitish plaga on each side behind the middle; with two very feeble tubercles (one in front of the other) on each at the base, and with the pubescence raised in two or three feeble tufts on each posteriorly, these tufts being partly black, partly fulvous; with also some small black dots, especially along the suture; with the apices somewhat obliquely truncate, prolonged more on the outer side, and without any sharp angles. Body underneath with a mixed pubescence of whitish, greyish, and fulvous. Antennæ brownish, speckled with grey and tawny, and with the scape at the apex, the second joint, and the base of the third more distinctly white.

The mandibles in the only male of the species which I have seen do not possess the upward processes so characteristic of the males of *S. grisator*, Fab.

Sthenias maculiceps, n. sp.

Apomecyna maculifrons, Chevr. MS.

Capitis fronte griseo-pubescente, genis albescentibus, fulvo-maculatis; capitis vertice maculis duabus parvis nigris; prothorace griseo-brunneo, lateribus subrotundatis; elytris brunneis nigro fulvoque minute maculatis, singulis ad latus plaga maxima griseo-albescente.

Hab. Ceylon.

Head with the pubescence in front greyish, at the sides whitish, with fulvous spots. Prothorax greyish brown. Elytra brownish, with a very large greyish-white patch on each side, this patch abruptly narrowed behind the middle, so that its posterior part is much narrower than its anterior, and with a black spot in the angle above which is thus formed. Breast greyish white, abdomen brownish.

This and the preceding species agree in size and general form, and differ from *S. grisator*, Fabr., in their relatively shorter prothorax, which is at the same time a little more rounded at the sides.

Mispila obscura, n. sp.

Obscure brunneo-griseo-pubescens, fusco et albo vage maculata; prothoracis disco tuberculis tribus parvis; elytris in medio obsolete transverse fasciatis, sparsim punctatis, punctis ad basin asperatis.

Long. 9–13 mm.

Hab. Nilghiri Hills (*Hampson*).

With an obscure brownish or fulvous-grey pubescence, with an irregular transverse band of a scarcely perceptibly darker shade on the middle of the elytra; this band somewhat fuscous on its anterior and posterior borders, where also may be seen a few minute white spots; with a few fuscous and one or two linear white spots on the posterior part of the elytra. Head and prothorax with small and sparse setigerous punctures; prothorax with three small tubercles on the disk and with one or two small fuscous spots towards the sides in addition to the minute brown specks which mark the position of the punctures. Elytra sparsely setigerously punctured, with the punctures somewhat asperate towards the base and becoming very feeble posteriorly. Body underneath and legs (a subnitid spot on the middle of each of the femora excepted) dull grey, with the posterior border of the first abdominal segment narrowly fulvous.

Enispia? cleroides, n. sp. (Pl. VII. fig. 7.)

Capite prothoraceque nigris, dense punctatis; elytris dense fortiterque punctatis, basi rufo-ferrugineis, nudis, deinde transversim fasciatis cum fasciis griseis (vel albis) et nigris alternatis; prothorace subtus nigro; pectore et segmento primo abdominis rufo-ferrugineis, segmentis ceteris nigris.

Long. 8, lat. $2\frac{3}{4}$ mm.

Hab. N. India.

Head and prothorax black, densely punctured. Elytra densely and rather strongly punctured on the basal two thirds, very sparsely and feebly on the apical third; reddish ferruginous and impubescent on the basal third; followed by transverse bands of white and black, of which the first is rather narrow, whitish towards the sides and greyish towards the suture; the second is a broad, opaque, black band, arcuate posteriorly, and with its front margin produced into three angles—one median sutural and one towards each side; this band is followed by a narrow white band, bowed forwards and placed just before the beginning of the apical third; the latter is black and subnitid, with a large pubescent and somewhat triangular white spot occupying the middle of it just before the apex. The underside of the meso- and metathorax and the basal segment of the abdomen are reddish ferruginous and sparsely punctured; the latter is bordered posteriorly with white, the rest of the abdomen behind it is black and shiny. From nearly all parts of the body as well as from the legs and antennæ long fine hairs are given off. Antennæ with the scape subcylindrical and shorter than the third joint, the fourth shorter than the third, the remaining joints gradually decreasing in length. Femora thickened in the middle; anterior tibiæ strongly enough bowed, the intermediate and posterior tibiæ feebly bowed.

This pretty and interesting little species I place with doubt in *Enispia*, as the form and relative proportions of the joints of the antennæ do not quite agree with those described for that genus.

Eunidia simplex, n. sp.

Supra fulvo-griseo-pubescens, subtus griseo-pubescens; lobis inferioribus oculorum longissimis; antennis fuscis, corpore plus sesquilongioribus.

Long. $5\frac{1}{2}$–$7\frac{1}{2}$, lat. $1\frac{1}{2}$–$2\frac{1}{4}$ mm.

Hab. Nilghiri Hills (*Hampson*).

Clothed with a dense fulvous-grey pubescence above and with a less dense greyish pubescence underneath. Front of head broad and nearly flat; lower lobes of eyes oblong, nearly twice as long as broad. Legs blackish brown, with a faint greyish pubescence. Antennæ with the basal joints nearly black, the remaining joints of a very dark ferruginous brown colour.

M. Lacordaire suspected that the species described from outside of Africa did not belong to this genus. The present species has all the characteristics of the genus.

Pemptolasius, n. g.

Head retracted in repose, with the front trapeziform, with the antennal tubercles subvertical and narrowly and triangularly separated from each other above. Antennæ a little longer than the body (♂), with the scape rather short and subcylindrical; with the third joint much longer than the scape, the fourth a little shorter than the third, the fifth and following joints subequal and each much shorter than the fourth; with the fifth joint and the apex of the fourth thickly fringed with black hairs underneath.

Prothorax cylindrical, unarmed at the sides, longer above than below, with the sternum surpassing the coxal cavities but little in front.

Elytra convex above, somewhat vertical at the sides, posteriorly declivous, and each with a short obtuse carina commencing at the shoulder and disappearing before the middle. Apices truncate.

Legs subequal, with the femora somewhat cylindrical, with the intermediate tibiæ grooved, and with the claws of the tarsi rather broadly divergent, but not divaricate.

With the intermediate cotyloid cavities open on the outside.

This genus may be placed provisionally near *Ectatosia*; it does not seem to fit well into any of Lacordaire's groups.

Pemptolasius humeralis, n. sp. (Pl. VII. fig. 8.)

Cinereo-pubescens; prothorace sparsim fortiterque punctato, supra lineis tribus longitudinalibus albis; elytris supra fortiter et dense punctatis, lateraliter minus dense punctatis; humeris glabris, nitidis, nigris.

Long. 13, lat. 4 mm.

Hab. Darjeeling.

With an ashy-grey pubescence. Head with the front sparsely punctured, the vertex more thickly punctured. Prothorax a little longer than broad, with its sides parallel; strongly and deeply punctured above and at the sides, the disk with three rather faint white lines—one median and one towards each side. Elytra broader at the base than the prothorax, rather closely and strongly punctured above, less densely punctured at the sides, each of the latter with two or three feebly raised lines; with a row of small white points along the disk of each elytron, and with one or two small white spots placed towards the side behind the middle of each; with the shoulders black and very glossy; with the apices of the elytra obliquely truncate. Legs with a greyish pubescence; femora with some scattered minute black points. Antennæ with the scape greyish, the remaining joints (the fifth excepted) pale brown, with a faint greyish pubescence and sparsely ciliate underneath; with the fifth joint and the apex of the fourth black, and thickly fringed with black hairs underneath.

Stibara suturalis, n. sp.

Fulvo-testacea, fulvo-pubescens; prothorace lateribus obsolete nigrovittatis, leviter tumidis nec tuberculatis; elytris lateribus distincte carinatis, disco obtuse minus distincte carinato, fulvis, cum sutura, vitta longitudinali utrinque et marginibus externis (prope basin exceptis) nigrescentibus; antennis omnino nigris.

Long. 18, lat. $5\frac{3}{4}$ mm.

Hab. S. India (Nilghiris, Belgaum).

Allied to *S. nigricornis*, Fabr. Elytra with the suture and the external margins (except near the base), as well as a longitudinal vitta on each, black; with three carinæ on each, of which one is lateral and, beginning close under the humeral prominence, extends in a nearly straight line to the external apical angle; the second, just above this, is very feeble, soon disappears, and seems to be a continuation of the humeral prominence; the third is placed about a millimetre higher up than the first and almost on the edge of the disk; along the inner side of this carina is a row of punctures, between it and the middle carina is a second row of larger and more distant punctures, while just beneath the first or lateral carina, near the middle of its length, is a short row of very small punctures. In *S. nigricornis* the arrangement of the carinæ and punctures is somewhat the same, but the lowermost or lateral carina of each side is less prominent, especially anteriorly; the median carina is much more distinct and is plainly seen to be a continuation of the humeral prominence; while the third or discal carina is much feebler. The punctures too are much fewer in number and placed more widely apart; but in this respect *S. nigricornis* is subject to vary. In the type specimen of Fabricius there are only four or five punctures in each row, while in other specimens twice this number is reached. In *S. nigricornis* the legs and underside of the body are generally greyish; in the present species they are distinctly fulvous, with the tarsi on their upperside and the abdomen and breast partly black.

From Mr. Thomson's too short diagnosis of *S. lateralis* I am quite unable to determine his species. It is from N. India. The species just described may possibly be the same or a variety of it.

EXPLANATION OF PLATE VII.

Fig. 1. *Xylotrechus Hampsoni.*
Fig. 2. *Batocera Polli.*
Fig. 3. *Coptops quadrimaculata.*
Fig. 4. *Thylactus dorsalis.*
Fig. 5. *Rhodopis alboplagiata.*
Fig. 6. *Sthenias albicollis.*
Fig. 7. *Enispia cleroides.*
Fig. 8. *Pemptolasius humeralis.*

VIII.—*Note on* Tealia tuberculata *and* T. crassicornis. By G. Y. and A. F. Dixon.

In a paper published in the 'Journal of the Marine Biological Association' (vol. i. p. 205) Mr. J. T. Cunningham endeavours to set up *Tealia tuberculata* (Cocks) as a species distinct from *Tealia crassicornis* (Müller). Perhaps we may be allowed to point out some matters that have occurred to us and which prevent our accepting his conclusions. There would appear to be no doubt whatever that Mr. Cunningham has obtained specimens identical with that on which Cocks based the description of his species *T. tuberculata*; but it seems to us that the accurate and detailed description which he gives of them leaves almost no room for question that these specimens belong to Gosse's species *T. crassicornis*. The points on which Mr. Cunningham separates *T. tuberculata* from *T. crassicornis* are:— (1) the occurrence of irregularly branched or bifurcated tentacles, which, so far as he is aware, have been observed only in *T. tuberculata*, though he admits that this is not a constant character of the species; (2) the slight irregularities in the number and arrangement of the tentacles which were exhibited by all the specimens of *T. tuberculata* which he examined, the conjectured normal arrangement being 5, 5, 10, 20, 40, 80; (3) he also states that *T. crassicornis* may be provisionally distinguished by the number of the tentacles, which are always arranged 5, 5, 10, 20, 40, while *T. tuberculata* possesses the ideal number given above; (4) he points out that in *T. tuberculata* the tubercles on the column are arranged in vertical series, while Gosse states that those of *T. crassicornis* are irregularly scattered.

These distinctions seem to us insufficient to separate the species in question. In the first place the occurrence of branched or bifurcated tentacles is not limited to any one species of Actinia. We have observed this phenomenon occurring occasionally in *Actinoloba dianthus*, *Sagartia miniata*, *Actinia equina*, *Anthea cereus*, *Bunodes gemmacea*, *Peachia hastata*, and more frequently in *Cylista undata*; but the most conspicuous instance of this peculiarity we have ever met with was in a large specimen of *T. crassicornis* adhering to an oyster-shell, and obtained from deep water in Dublin Bay in January last. In this specimen several of the tentacles were abnormally developed with warts or branches. Gosse considered the tendency of the tentacles to a monstrous fission the most marked peculiarity of Cocks's specimen; Mr. Cunningham admits that this tendency is not exhibited by some individuals otherwise similar to Cocks's specimen, and we see that it may be present in *T. crassicornis*, the very species from which it is desired to separate some individuals on the ground that they possess this peculiarity. Secondly, as to the irregularity in the tentacles observed by Mr. Cunningham, we should not be inclined to lay much stress on this point in the case of individuals so large as those which he describes. He himself shows that the normal arrangement corresponds with that in *T. crassicornis* so far as the latter goes, and that the irregularity in *T. tuberculata* is due to deficiencies in the outer cycle of the tentacles. Further, it is not uncommon to find in adult individuals of other species of Actiniæ possessing numerous tentacles similar departures from the regular type. Even in *Bunodes verrucosa*, in which, as a rule, the regular arrangement is singularly conspicuous, we have observed a somewhat similar numerical deficiency (Proc. Roy. Dubl. Soc. vol. vi. p. 321). Indeed, in large specimens, one could hardly expect to find the full number of tentacles always present in the outer and, therefore, newer cycles; for to preserve such regularity in growth the tentacles in each cycle should be simultaneously developed, and it should be remembered that such an absolutely symmetrical development of mesenteries as this would suggest is not usually met with among Actiniæ with numerous mesenteries. Mr. Cunningham himself can hardly consider the irregularity in the tentacles to be of specific importance; for were he to do so, to be logical, he should exclude the individuals which he has described as well from the genus *Tealia*, as defined by himself, as from the species *T. crassicornis*. Thirdly, as to the greater number of tentacles observed by Mr. Cunningham in *T. tuberculata* compared with the number assigned by Gosse to *T. crassicornis*, we do not see why this should not be compatible with the identity of the two species. The individuals referred to *T. tuberculata* are evidently larger than those found along the shore between tide-marks, which formed the material on which Gosse based his description of *T. crassicornis*; and it seems reasonable to suppose that the number of tentacles increases with the growth of the animal. Fourthly, as to the tubercles being arranged in vertical rows in *T. tuberculata*, we have shown that the same is the case with *T. crassicornis* (*l. c.* pp. 319, 320). We do not think that the fact that Cocks's and Mr. Cunningham's specimens were attached to the valves of Lamellibranchs, instead of being found in the clefts of rocks, is anything more than a different habit necessarily assumed by the animals in the different regions from which they were obtained. We may add that we have never seen a *T. crassicornis* brought from deep water except on a shell or stone. Mr. Cunningham points out that the surface of the column is almost always bare of pebbles and sand, though furnished with suckers; we have invariably found this to be the case with specimens of *T. crassicornis* dredged in deep water.

From what we have already said it is apparent that we cannot follow Professor Haddon (Trans. Roy. Dubl. Soc. ser. 2, vol. iv. p. 321) in regarding *Tealia tuberculata* as a possible synonym of *Actinauge Richardi*. Owing to Prof. Haddon's kindness we have had an opportunity of seeing Cocks's original drawing, and we can only state that it is quite possible it was made from a merely overgrown specimen of *T. crassicornis*. While, therefore, as Gosse says, *T. tuberculata may* be a true species (Actin. Brit. p. 217), we must state our belief that as yet its distinctive specific characteristics have not been diagnosed.

Mr. Cunningham arrives at the conclusion that *Bolocera eques*, Gosse, is the same as *Tealia tuberculata*. But it appears a rather high-handed course to ignore totally the non-retractility of the margin, which Gosse made one of the distinguishing features of the genus *Bolocera*, and, in addition, to assume that Gosse is mistaken in the number he assigns to the tentacles. We do not think that such an accurate observer as Gosse can have gone so far astray in a matter of external form.

We cannot conclude without expressing our surprise that Mr. Cunningham has included in the genus *Tealia*, defined by himself as possessing a decimal arrangement of parts, such a form as *T. bunodiformis*, Hertwig, which has been described in the 'Challenger' Report (p. 35) as possessing parts certainly not conforming in number or disposition to this definition. We have elsewhere urged the probable identity of *T. bunodiformis* and *Bunodes thallia*, Gosse (*l. c.* p. 319); but, in any case, it must be widely separate from such a well-defined genus as *Tealia*.

IX.—*Tenth Contribution to the Knowledge of the Fauna of Madagascar* *. By Dr. A. Günther, F.R.S.

[Plate VI.]

A small collection made by the Rev. James Wills in the forest-district east of Imerina contained a few new or interesting species.

Among the Mammalia there is a specimen of a very peculiarly coloured species of *Hemicentetes*.

Hemicentetes nigrofuscus.

This species agrees with *Hemicentetes semispinosus* in size,

* 9. "Ninth Contribution to the Knowledge of the Fauna of Madagascar," Ann. & Mag. Nat. Hist. 1882, vol. ix. p. 262.

the proportions of the body, and the distribution of the ornamental markings; but what is yellow or whitish in *H. semispinosus* is of a bright light chestnut-colour in this species, and the middle of the chest and abdomen is black.

In the only specimen available at present the fur is very thin and consists on the side of the abdomen of thin woolly hairs, sparsely mixed with very slender bristles. The crest across the nape is formed by less numerous spines, which, like all the spines on the back, are of a deep orange colour. Thinner black bristles are mixed with the hair as in the allied species *.

The dentition is that of an adult animal and formed by the permanent teeth. On comparing it with a specimen of *H. semispinosus* of the same size, no great difference can be observed as to the general shape and relative position of the teeth. But the molars are of conspicuously larger size and are less broad transversely, with the exception of the hindmost (fourth) molar, which is rudimentary. The distance of the canine from the front incisor is 4 millim., that between the canine and second præmolar 7 millim.

Only one specimen was obtained; the skin is 140 millim. long, and the head measures 40 millim. to the front margin of the ear.

The Reptiles consist of specimens of *Sepsina gastrosticta*, O'Sh.; *Chamæleon lateralis*, Gray; *Chamæleon brevicornis*, Gthr.; *Chamæleon globifer*, Gthr.; *Chamæleon nasutus*, Gray; and *Chamæleon Willsii*, sp. n. Among the Snakes specimens of *Ptyas infrasignatus*, Gthr. (1882), are of special interest, inasmuch as they prove that *Dromicus Stumpffi*, Böttg. (1881), and *Dromicus Baroni*, Blgr. (1887), are individual variations or modifications of age of the same species †. *Dipsas colubrina* is represented in this collection and seems to be generally distributed.

A species of *Liophis* I believe to be undescribed, and, finally, *Mimophis madagascariensis*, Gthr., occurs also in this district.

* I may here mention that *Hemicentetes nigriceps*, Günth. (Ann. & Mag. Nat. Hist., Aug. 1875), has since been renamed by Jentink *Hemicentetes variegatus*, var. *Buffoni* ('Notes from the Leyden Museum,' 1879, p. 150). I am afraid that Dr. Jentink will be still less inclined to acknowledge the form now described as a distinct species.

† *Dromicus madagascariensis*, Gthr., proves to be very distinct, although it has a similar coloration. Its head is much shorter and broader, the eye smaller, and in all specimens known the abdomen is unspotted, as in some of *Ptyas infrasignatus*.

Chamæleon Willsii. (Pl. VI.)

This species is closely allied to *Chamæleon minor* (Ann. & Mag. Nat. Hist. 1879, vol. iv. p. 246), but differs by its broader head, which is quite flat between the orbits in the female, and very slightly concave in the male, whilst in *Chamæleon minor* the upperside of the head is deeply concave in both sexes. Snout of the adult male produced into two flat compressed horns, divergent in front and covered with large scutes, of which one in the middle of the upper edge projects like a prong; the horns are much less approximate at the base than in *Chamæleon minor*; they are, as usual, absent in the female. Occipital region with a rounded margin behind, without any prominent parietal crest, which in *Chamæleon minor* is rather conspicuous. No lateral occipital flaps. A dorsal crest is present in the male only, and consists of a few conical tubercles which occupy the nape of the neck. No gular or ventral median series of tubercles. Head covered with small, flat, irregular scutes; scutes of the body uniform, flat, scarcely smaller than those of the head, but much larger than in *Chamæleon minor*. Heel without spur or prominence.

Dark greenish or yellowish, with a white streak along the median line of the throat and abdomen; a narrow yellow ring round the middle of the foot; a similar marking is indicated by one or two small spots on the hand; female with an interrupted yellow line along the hinder side of the hind limb and continued for a short distance on each side of the tail.

Four specimens were collected, two adult males and two females. The larger of the males is $6\frac{1}{2}$ inches long, the tail measuring $3\frac{1}{2}$ inches. The fully adult female is smaller, measuring only $4\frac{1}{2}$ inches, of which the tail takes one half.

Liophis Imerinæ.

Scales in nineteen series. Head short, snout rather pointed; eye small, with round pupil. Rostral shield protruding, extending on to the upper surface of the head; frontals small, the anterior scarcely one half the size of the posterior; vertical longer than broad; occipitals as long as vertical and postfrontals together. Loreal short; one præocular, not reaching to the upper surface of the head; two postoculars. Eight upper labials, the fourth and fifth entering the orbit. Temporals $1+2+3$, the foremost in contact with the lower postocular only. Three lower labials in contact with the anterior chin-shields.

Ventrals 146; anal divided; subcaudals $28+x$, possibly 40. Posterior maxillary tooth strong and separated from the preceding by an interspace.

Upper parts brown, with four rather indistinct blackish lines, the outer along the fourth and the inner along the seventh series of scales; upper labials yellowish, marbled with blackish like the throat; lower parts greyish, nearly black.

The length of the single specimen is 18 inches, of which the somewhat mutilated tail measures two.

This species seems to be allied to *Liophis quinquelineatus* (Ann. & Mag. Nat. Hist. 1881, vol. vii. p. 359), of which the type has been lost. It differs, however, by its somewhat larger eye, fewer series of scales, and different coloration of the head.

X.—*Report upon the Crustacea collected by P. W. Bassett-Smith, Esq., Surgeon R.N., during the Survey of the Macclesfield and Tizard Banks, in the China Sea, by H.M.S. 'Rambler,' Commander W. U. Moore.* By R. I. Pocock.

This collection of Crustacea is composed principally of Brachyurous forms of small size. Seventeen species have been identified, and of these three are now described for the first time. This percentage of new species from seas so well known is distinctly good. The chief interest centres in the Maioid forms, two of them being new to science and the rest noticeable in other respects.

In addition to the species here enumerated several small specimens of a species of *Alpheus* were taken; but the identification of these has not been attempted, on account of their immaturity and imperfect condition.

1. *Gonodactylus chiragra* (Fabr.).

One small specimen in 3 feet of water at the north-east extremity of the reef.

2. *Galathea australiensis*, Stimpson.

Galathea australiensis, Stimpson, Proc. Ac. Sci. Philad. p. 89 (1858); Henderson, Anomura of 'Challenger' Exped. p. 118, pl. xii. fig. 5.

Two specimens without chelipedes in 32 fathoms of water on Macclesfield Bank.

3. ? *Dynomene hispida*, Desmarest.

Dynomene hispida, Desmarest, Consid. gén. Crust. p. 133, pl. xviii. fig. 2.

A single specimen, perhaps not referable to this species, on Macclesfield Bank, 32 fath.

4. *Nursilia dentata*, Bell.

Nursilia dentata, Bell, Trans. Linn. Soc. xxi. p. 309, pl. xxxiv. fig. 6.

A single female specimen at a depth of 40 fath.

5. *Caphyra lævis*, A. Milne-Edwards.

Caphyra lævis, A. Milne-Edwards, Nouv. Arch. Mus. v. p. 152, and ix. p. 173, pl. iv. fig. 2.

One specimen in 3 feet of water on Extreme Reef.

6. *Tetralia cavimanus*, Heller.

Tetralia cavimanus, Beiträge zur Crustaceen-Fauna des rothen Meeres, p. 353, pl. iii. figs. 24, 25.

Three specimens from Mace Island at a depth of $20\frac{1}{2}$ fath.

7. *Trapezia cærulea*, Rüppell.

Trapezia cærulea, Rüppell, Miers, Brachyura of 'Challenger,' p. 165.

A single specimen on Extreme Reef in 3 feet of water.

The lateral spines of the carapace are almost obsolete; the manus is rounded above and not hairy externally.

8. *Trapezia cymodoce* (Herbst), Miers.

Trapezia cymodoce (Herbst), Miers, Ann. Nat. Hist. (5) ii. p. 408.

Taken with the above was a single specimen of *Trapezia* which is referable to *T. cymodoce* as restricted by Miers. It may be distinguished from those that I have named *T. guttata* by the absence of spots from the legs and by the presence of a cluster of very short hairs on the outer surface of the manus of the chelipede.

9. *Trapezia guttata*, Rüppell.

Trapezia guttata, Rüppell, Beschreib. Krabben des rothen Meeres, p. 27.

Half a dozen small specimens in 6 fathoms off Tizard Bank.

Our knowledge of the species of the genus *Trapezia* is in a very unsatisfactory state. I refer these specimens to *guttata* of Rüppell on the strength of the following characters:—a uniformly coloured thorax with a spine on each side of it, and legs bearing more or less faint indications of spots.

10. *Actumnus setifer*, de Haan.

Actumnus setifer, de Haan, Crustacea in Siebold's 'Fauna Japonica,' p. 50, pl. iii. fig. 3.

A small specimen on Macclesfield Bank at a depth of 32 fathoms.

11. *Daira perlata* (Herbst).

Daira perlata (Herbst), Milne-Edwards, Crust. i. p. 387.

A single specimen taken in 3 feet of water at the north-eastern extremity of the reef.

12. *Actæa tessellata*, sp. n.

Carapace wide, about as wide in proportion to its length as in *A. rufopunctata*, but more rounded at the sides; furnished in every part with distinctly defined lobes which exactly resemble the similar lobes in *A. rufopunctata* in being covered with rounded close-set granules; the depressions which separate these lobes are clothed with short hairs; at the edge of the carapace the lobes are not distinct, as in *rufopunctata*, but merely represented by clusters of sharper granules, which give to the carapace the appearance of being laterally spinulose; the frontal region furnished with four lobes, as in *rufopunctata*; margins of the orbits granular, but less distinctly lobate than in *rufopunctata*; the anterior half of the carapace, behind the orbits and the posterior frontal lobes, is furnished as in *rufopunctata* with eight lobes arranged in a transverse series; of this series the two which are close to the middle line are almost continuous in front with the posterior frontal lobes, while behind they are separated from each other by a very conspicuous elongate median lobe; at the posterior extremity of this and on each side of it there is a single small rounded lobe, and behind these three a single transverse lobe. This arrangement of granular lobes in this region of the carapace does not occur in any specimen of *rufopunctata* that I have seen; the arrangement of lobes on the rest of the carapace is much the same in the two species.

Chelipedes nearly smooth on the inner surface, granular externally, the granules on the carpus arranged more or less in clusters, on the manus in transverse series; the dactyli compressed and blade-like, the movable one slender and arched, granulate above, but on the inner surface feebly dentate only at the base; the immovable one obscurely dentate and thick from above downwards.

Legs very hairy and granular, as in *rufopunctata*, but not, as in that species, lobate.

Two specimens (♂ and ♀) on Extreme Reef in half a fathom of water.

The colour (in alcohol) of these specimens is a kind of pale reddish grey; the smooth parts of the limbs darker slate-grey, dactyli dark brown. In one specimen (the male) the lower half of the manus is black both on the inner and on the outer side. Whether this colouring is sexual or only "accidental" cannot of course be determined.

This species is more nearly allied to *rufopunctata* than to any other known to me, but may be separated from it by many well-marked characters. In addition to those already referred to in the description mention may be made of the form of the fingers and the absence of the red colouring-matter.

Width of carapace 14, length $9\frac{1}{4}$ millim.

13. *Actæa rufopunctata*, M.-Edw.

Actæa rufopunctata, A. M.-Edw. Nouv. Arch. Mus. i. p. 268, pl. xviii. fig. 1 (1865).

A single specimen in 3 feet of water on Extreme Reef.

14. *Parthenolambrus calappoides*, Adams & White.

Parthenolambrus calappoides, Adams & White, Crust. in Voyage of 'Samarang,' p. 34, pl. v. fig. 5.

A single individual of large size at a depth of 27 fath. on the edge of the reef off Nam-yit.

The carapace gives the following measurements:—Length $22\frac{1}{4}$, width 33 millim.

This, the largest specimen that I have seen of the genus, I was at first inclined to look upon as the type of a new species mainly on the strength of the great erosion that the upper surface of the carapace presents. But an inspection of the series of *P. calappoides* in the Museum soon showed that this character is exceedingly liable to variation—in fact that no two individuals have the carapace similarly eroded.

15. *Hyastenus* (*Chorilia*) *tenuicornis*, sp. n.

Carapace pyriform, with well-defined regions; the rostral spines hairy, exceedingly long and diverging, *i. e.* each spine is considerably longer than the carapace and the distance between their apices is about equal to their length; the supernumerary rostral tooth, which is said to be characteristic of the genus *Naxia*, is absent; the antennal and orbital spines are very strong; from the base of each there runs backwards towards the margin of the posterior half of the orbit a tooth which in the case of the orbital spine partially bridges over the upper orbital hiatus; the orbital hiatus very large and the posterior portion of the orbit in consequence small and pillar-shaped; from its upper surface it sends forward a projection in the direction of, but not reaching, the backwardly prolonged tooth from the upper orbital spine; these two projections almost fill up the aperture of the upper orbital hiatus; the superior interorbital area furnished with two subparallel longitudinal series of tubercles; the gastric region of the carapace furnished with larger and smaller, not close-set tubercles, of which three in the middle line and one on each side are the largest; the cardiac region armed with two enormous tooth-like tubercles set in longitudinal series; the branchial region armed with three large teeth, of which the hindmost is the largest.

Chelipedes long, projecting slightly beyond the apex of the rostral spines; merus cylindrical, furnished at its distal end with a spine above and an articular tubercle on each side; manus long and slender, with an articular tubercle above and below at its proximal end and a longitudinally grooved external surface.

Legs almost alike, differing principally in length and in the fact that the merus of the first pair is furnished at its distal end with an enormous spine, which is scarcely represented on the other legs.

Measurements in millimetres.—Length of carapace 10, width 7, width outside orbits $4\frac{3}{4}$; length of rostral spine $12\frac{1}{2}$; distance between apices of spines $12\frac{1}{2}$; length of chelipede $17\frac{1}{2}$, of first leg $27\frac{1}{2}$, of last 13.

The colour (in spirit) of this specimen is very beautiful; the bases of the legs and of the rostral spines, the interorbital area, and the antero-lateral portions of the carapace are carmine, the upper portions of the branchial region are bluish grey, the rest yellowish white.

One specimen at a depth of 32 fath., another at a depth of 25 fath., on Macclesfield Bank.

This species is very distinct from all known to me, and is to be at once recognized by its enormously long and divergent rostral spines and by the long and slender spinule which is situated at the distal extremity of the merus of the first pair of legs. It somewhat resembles *Hyastenus oryx* of A. Milne-Edwards *, but differs in the armature of the cephalothorax and in its long and diverging rostra. In possessing two median, large, erect spines on the cardiac lobes of the carapace it appears to be allied to *Naxia hystrix* and to *Naxia elegans*.

16. *Naxia taurus*, sp. n.

Carapace pyriform, with gastric, cardiac, and branchial regions well defined by conspicuous smooth sulci; the whole surface covered with distinct though close-set minute tufts of hair, amongst which, especially in the gastric and branchial regions, project a few longer and coarser hairs; the rostral spines long and diverging, *i. e.* each spine is considerably longer than half the length of the carapace, and the distance between the tips of the spines is a little more than three quarters the length of each, coarsely and sparsely hairy in the proximal half of the inner surface, the additional spine is large and situated far from the apex near the middle, but in the distal half of the upper surface; antennal spine long and strong, but less strong than the superior orbital spine; the external half of the orbital margin is bidentate above and hairy on the inner surface; the superior interorbital area is furnished with two subparallel longitudinal series of tubercles, which extend, increasing in size from before backwards, almost from the base of the rostrum to the gastric region; gastric region armed with many symmetrically-disposed tubercles; three of these are very large and situated in the middle line, on each side of the anterior and posterior of these are two transversely disposed smaller tubercles, and in addition there are several still smaller tubercles scattered about; the anterior half of the cardiac region furnished with a cluster of small tubercles and the posterior half with three larger tubercles arranged in the form of a triangle; the hepatic and lateral portions of the branchial region covered with many small tubercles, the upper portions of the branchial region armed with fewer tubercles—on the epibranchial portion there is one large tooth and on the inner side of this a few smaller close-set tubercles, and on the metabranchial portion two or three widely separated small tubercles and a larger external tooth.

* Nouv. Arch. Mus. viii. p. 250, pl. xiv. fig. 1.

Chelipedes when extended reaching slightly beyond the apex of the rostral spines; merus cylindrical and armed above with a single sharp spine situated at its distal extremity; manus cylindrical, furnished with an articular tubercle above and below at its proximal end; fingers slightly separated basally when closed.

Legs almost alike, differing principally in length, the first pair being much the longest; the segments are all simple and cylindrical, the merus alone being armed distally with a sharp spine; this spine, very large on the first pair, becomes gradually smaller from before backwards on the others, and finally disappears on the fourth.

Measurements in millimetres.—Length of carapace (without rostrum) $20\frac{1}{4}$, width 14, width behind orbits 7; length of rostral spine 12, of tooth from base $6\frac{1}{2}$; distance between apices of spines $9\frac{1}{4}$; length of chelipede 25, of first pair of legs $57\frac{1}{2}$, of last pair 26.

A single specimen on Macclesfield Bank at a depth of 32 fathoms.

Provisionally following Mr. Miers I refer to the genus *Naxia* those species allied to *Pisa* and *Hyastenus* which are characterized by the presence of an accessory spine or spinule on each of the rostral projections. Thus restricted the genus contains the species mentioned by Mr. Miers on p. 60 of his Report on the Brachyura of the 'Challenger,' and, in addition, two that are here added. Of these one is the species described above, the other is *N. elegans*, a species referred by Mr. Miers (*loc. cit.* p. 58) to the genus *Hyastenus*. Whether this species is more nearly allied to the typical *Hyastenus* than to the typical *Naxia* it is difficult to say; but at all events it unquestionably possesses the rostral spinules by which alone, according to Mr. Miers, the genus *Naxia* may be separated from *Pisa* and *Hyastenus*. Curiously enough these spines, which, although small, are very distinct, appear to have been overlooked by both author and artist; for no mention is made of them in the description, and in the figure that accompanies it no sign of them is to be detected. It is very questionable whether a genus should be retained on so slender a basis, and there appears to be but little doubt that a revision of *Pisa*, *Hyastenus*, and *Naxia* will show that the three can scarcely be regarded as distinct genera. It is for convenience' sake alone that *Naxia* has been here restricted to those few forms presenting an accessory rostral spine. The following table will perhaps serve to show how these may be separated from each other:—

a. Carapace armed wholly or principally with large spines and spiniform prominences; meral segments of appendages armed distally with a single spinule.

a^1. Rostral spines less than a third the length of the carapace and widely diverging; legs very long. . . . . *hystrix*, Miers *.

b^1. Rostral spines considerably more than half the length of the carapace; legs shorter.

a^2. Rostral spines subparallel, diverging only near apex; intestinal region of carapace armed with three spiniform projections . . . . *Robillardi*, Miers †.

b^2. Rostral spines diverging gradually from the base; intestinal region of carapace armed with only one large spiniform projection . . . . *elegans* (Miers) ‡.

b. Carapace armed principally with more or less close-set, blunt, tuberculiform teeth, amongst which, especially on the branchial region, a few spines may project.

a^3. Rostral spines more than half the length of the carapace and diverging strongly from the base; meral segments of the appendages distally spined. *taurus*, sp. n.

b^3. Rostral spines less than one third the length of the carapace and subparallel; meral segments armed distally with a tubercle.

a^4. Orbital spine not large; rostral tooth situated some distance from the apex of rostrum . . . . *hirta*, A. Milne-Edw. §

b^4. Orbital spine conspicuous; rostral spine situated close to the apex of rostrum. . . . . *serpulifera*, Milne-Edw. ||

17. *Huenia proteus*, de Haan.

Huenia proteus, de Haan, Siebold's 'Fauna Japonica,' Crustacea, p. 95, pl. xxiii.

A single specimen in 3 feet of water on Eldad Reef.

This specimen, although a male, is furnished with those

* Brachyura of 'Challenger,' p. 60, pl. vi. fig. 4.
† Proc. Zool. Soc. p. 339, pl. xx. fig. 1 (1882).
‡ Brachyura of 'Challenger,' p. 58, pl. vi. fig. 3 (sub *Hyastenus*).
§ Ann. Soc. Ent. Fr. (4) v. p. 143, pl. iv. fig. 1.
|| Hist. nat. Crust. i. p. 313.

antero-lateral laminar processes which are usually confined to the female.

On each side of the rostrum and attached to the hairs which adorn this portion of the cephalothorax there is a single branching piece of the Alga, *Galaxaura fragilis*, in a cluster of which this crab was taken.

XI.—*On the Species* Rallus pusillus *of Pallas and its Allies.* By W. R. Ogilvie Grant.

While recently engaged in arranging the Rails in the National Collection I was struck by the difference in appearance between the Pigmy Rails from the Indo-Chinese countries and those from Europe, Africa, and Madagascar, which have always been regarded as belonging to one species and known as *Porzana Bailloni*. A more careful examination of our large series at once convinced me that this is a mistake, and that the Indo-Chinese bird, of which Mr. Hume's collection contains a very fine series, is in reality very distinct from the true *P. Bailloni*, which is the Western form, both in plumage and geographical distribution. There can be no doubt whatever that the Eastern bird is the one described by Pallas in his 'Reise Russ. Reichs,' iii. Anhang, p. 700, under the name of *Rallus pusillus*, a name which was doubtfully referred by Mr. Dresser to the synonymy of *P. Bailloni* and added to the synonyms of that species by Mr. Seebohm in his 'British Birds,' although he preferred to retain the name *Bailloni* used by the majority of authors. Pallas obtained his specimens in Dauria, and gives an excellent description, which I shall quote, as it clearly gives the characters which distinguish *pusillus* from *Bailloni*. The Eastern species must stand in future as:—

Porzana pusilla (Pall.).

"*Colore* et forma perquam similis *Rallo aquatico*; sed *magnitudo Alaudæ vulgaris*. *Facies*, collum subtus et pectus medium longitudinaliter cærulescenti-cana, media *gula* candicat. *Litura* per oculos longitudinalis obsolete ferruginea. *Vertex*, cervix, dorsum ferrugineo nigroque liturata; *dorsum* lineolis longitudinalibus vagis albis. *Abdomen* crissumque nigra, tæniolis albis transversis. *Cauda* inter alas compressa, arrigua. *Pedes* virescentes."

As compared with *Porzana Bailloni* it may be briefly characterized as very similar to the Western species both in size and general appearance, but differing in the following particulars:—

The adult male has a brown stripe of the same colour as the back, which traverses the slate-grey side of the face from the base of the upper mandible to the neck, passing through the eye and across the ear-coverts. (In *P. Bailloni* the side of the face is uniform dark slate.) The upper surface is lighter brown and not so heavily splashed with white, while the under surface is greyish white instead of dark slate-grey. It will be noted that Pallas particularly mentions the stripe on the side of the face passing through the eye, which is the most striking of the differences, which are in no way due to season.

The adult females of both the Eastern and the Western species resemble their adult males, but are not quite so richly coloured, and the breast is less pure and mixed with buff.

The young of both species are very similar, but the young of *P. Bailloni* appear to have the sides of the face nearly white. In *P. pusilla* they are brownish buff.

Mr. Seebohm, in his 'British Birds,' ii. p. 546, in describing *P. Bailloni*, has based his descriptions on both species, for the male only is true *P. Bailloni*, while the female belongs to *P. pusilla*. He has kindly allowed me to examine his collection of *Porzana*, and having also reexamined the material, is quite of the same opinion as myself. He mentions on p. 543 that "the geographical distribution of Baillon's Crake is either imperfectly known or is a very singular one;" but owing to his believing the sexes to be different, as already mentioned, and having only a few sexed specimens in his collection, he failed to recognize the distinctness of the Eastern and the Western forms.

Although the plate of Baillon's Crake given in Messrs. Hume and Marshall's 'Game Birds of India, Burmah, and Ceylon' is the identical one used in Dresser's 'Birds of Europe,' it is curious to observe that it has been altered in the former work, and the cheek-stripe already mentioned in my description of *P. pusilla* has been added, so that in that respect the Indian bird is fairly represented, though in many other points, as already observed by Mr. Hume, the plate is not satisfactory.

Both *P. Bailloni* and *P. pusilla* are easily distinguished from the Little Crake, *P. parva*, with which they have been and are so often confused, not only by their smaller size, but by having the outside web of the first primary white instead of brown, and the sides and flanks barred with black and white, of which there is scarcely a trace in *P. parva.*

In attempting to point out the different ranges of these three species I shall only draw conclusions from the specimens I have seen, and such references as there can be little or no doubt about.

The range of *Porzana pusilla*, so far as I can ascertain from the specimens before me, is throughout the Indian peninsula (except Sindh, though Mr. Hume mentions that a specimen of *P. Bailloni* (*P. pusilla*, mihi) was shot by Mr. Blanford at Manchur Lake, in Sindh; but I have not seen it), extending south to Ceylon and the Andaman Islands. It occurs north of Tavoy, and extends through China to the Philippine Islands, and has been obtained at Bintulu, in N.W. Borneo. It occurs in Afghanistan, and is recorded from Beluchistan, Turkestan, Dauria, S.E. Siberia, and Japan; but it seems to me probable that the specimens from Beluchistan have been wrongly identified, and should be referred to *P. parva.* Mr. Scully says it is a summer visitor in small numbers to the main valleys round Gilgit.

With regard to *P. parva*, which he also obtained at Gilgit, Mr. Scully says, "This species appears merely to pass through the district in spring and autumn. It is found in Sindh in winter; and the birds that visit us probably breed further north." It is common in Sindh, and we have specimens from Beluchistan, Afghanistan, Turkey in Asia, South and Central Europe, and Britain, as well as one from Mtesa's Country, which lies just north of Lake Victoria Nyanza.

The true *Porzana Bailloni* is a straggler to Great Britain and ranges from South and Central Europe to the Cape Colony and Madagascar. A specimen was obtained by Mr. Cumming at Fao, at the head of the Persian Gulf.

So far as is known the ranges of *P. pusilla* and *P. Bailloni* are widely separated, and *P. parva* occupies the intermediate country as well as being found in part of the country occupied by each.

XII.—*Critical Notes on the Polyzoa.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

Part II.*—CLASSIFICATION.

1. *Preliminary Section.*

MANY years have now elapsed since the publication of Smitt's fruitful work on the Scandinavian Polyzoa †, in which a new basis of classification was proposed and the foundations of a natural system were sought, not in the comparatively trivial variations of colonial growth and habit, but in the more significant and essential characters of the individual zoœcium. When it is remembered that the older classifications were founded primarily, without exception, on zoarial peculiarities, we can feel little surprise that the proposals of the Swedish naturalist, discrediting as they did the fundamental principle on which they rested, were at first regarded as too revolutionary in character, and failed to produce any immediate effect on the systematic treatment of the Polyzoa. Probably, too, the fact that his great work, containing a singularly able and exhaustive account of his researches and theoretical views, is written in the Swedish language may help to account for the comparatively long period during which its specific claim was almost unrecognized and its influence but slightly felt. Certain it is that so late as 1880, when my 'History of the British Marine Polyzoa' was published, the principal writers on the Class gave at least a nominal adherence to the old views, and that in no systematic work had Professor Smitt's principles been adopted and applied.

To estimate rightly the work which the Swedish naturalist has accomplished in this department of zoology we must remember that it is not a mere revision of an existing system that we owe to him, but the institution of a new system, resting on new foundations, and implying a new interpretation of the facts with which it deals. His distinctive merit is that he substituted zoœcial for colonial characters as the proper basis of a natural arrangement, thus giving a new direction to research and preparing the way for a system which

* Part I. was published in the 'Annals' for February 1887.

† "Kritisk förteckning öfver Skandinaviens Hafs-Bryozoer," Öfvers. af Kongl. Vetenskaps-Akad. Förhandlingar, 1864–67. In 1867 the principles on which his classification was founded were discussed in a paper entitled "Bryozoa Marina in regionibus arcticis et borealibus viventia, recensuit F. A. Smitt," Öfvers. K. Vet.-Akad. Förh. 1867, no. 6.

should rest not on mere superficial resemblances, but on genetic affinity.

The details of his classification—his definitions of genera, his identifications of species, his grouping of varietal forms, and other points—may be open in some cases to criticism and revision; but it may be safely affirmed that he has indicated the direction which all sound and fruitful research must take for the future *.

Within the last few years there has been a very general acceptance of Prof. Smitt's fundamental principle amongst students of the Polyzoa, though there are still serious diversities of opinion as to the zoœcial elements which possess the highest systematic value, and we must await the results of yet further investigation before we may hope to realize a perfect system. In the meantime it may be useful to indicate the nature and scope of some of the differences which exist amongst writers on the Polyzoa, and endeavour to estimate our actual position with reference to systematic questions.

Amongst those who in recent times have occupied themselves with these questions I may name Jullien†, Koschinsky‡, and Pergens and Meunier §. Waters too, in his numerous papers (chiefly on fossil forms) and in his supplementary notes on the 'Challenger' Polyzoa, has given us many interesting suggestions bearing on systematic points which merit careful consideration. To some of these I hope to refer hereafter.

All these writers are agreed in seeking the basis of classification amongst the characters of the zoœcium, so far at least as the Cheilostomata are concerned. Pergens and Meunier adopt in great part, though only provisionally, the revision

* It must be remarked here that Smitt did not carry out his principle in the arrangement of the Cyclostomata. He says, "Formæ vero Cyclostomatum sicut in antiquioribus geologiæ temporibus maxime floruerunt, sic etiam inferiorem evolutionis gradum retinuerunt, ita ut, quamvis variis figuris coloniarum abundet hic ordo, zoœcia fere æqualia præbeat" ("Bryozoa Marina in regionibus arcticis et borealibus viventia," Öfversigt af Kongl. Vetensk.-Akad. Förhandl. 1867, no. 6, p. 467.

† "Note sur une nouvelle division des Bryozoaires Cheilostomiens," Bulletin de la Soc. Zool. de France, t. vi. (1881); "Monographie des Bryozoaires d'eau douce," *ibid.* t. x. (1885); "Les Costulidées, nouvelle Famille de Bryozoaires," *ibid.* t. xi. (1886); 'Mission du Cap Horn, Bryozoaires.'

‡ "Ein Beitrag zur Kenntniss der Bryozoen-Fauna der älteren Tertiärschichten des südlichen Bayerns," i. Abtheil., Cheilostomata. Palæontographica, herausgegeben von Karl A. von Zittel, Band xxxii. Erste Lieferung, 1885.

§ "La Faune des Bryozoaires Garumniens de Faxe," Ann. de la Soc. Malacologique de Belgique, tom. xxi. (1886) pp. 12, 13.

and extension of Smitt's system, which I have embodied in my 'History' of the British species. They take exception at the same time to the importance assigned to the zoœcial orifice, which (they hold) is liable in many species to remarkable variations and cannot be regarded as a stable character. They say:—"Celui-ci (l'orifice zoécial) présente dans beaucoup d'espèces des différences remarquables, et substituer une classification basée principalement sur le seul caractère de cette ouverture à celle qui avait principalement en vue la forme de la colonie, c'est remplacer une classification artificielle par une autre, toujours moins éloignée de la réalité. On ignore encore quels sont les caractères réellement stables dans les Cheilostomes aussi bien que dans les Cyclostomes" *. They add, "Dans ces derniers (Cyclostomes) presque tout est encore à faire; dans les premiers, M. Hincks s'attache presque exclusivement à la forme de l'orifice zoécial."

Upon this I would remark that the latter statement can hardly be accepted as a correct representation of the actual fact. I have not relied by any means "exclusively" on the form of the orifice in forming genera, nor has it been as a matter of choice that I have in any case contented myself with a single character; much less can it be said with truth that it has been my purpose to make the zoœcial orifice, as a substitute for the colonial form, the basis of my classification. My primary object has been to give effect to the new systematic principle *in the best way which the actual state of our knowledge would permit*; and if in some cases the structure of the zoœcial orifice has been adopted singly as the basis of generic groups, it is simply because, from the imperfection of our knowledge, no other characters of equal stability and significance could be found. I will reproduce here the following passage from the "Introduction" to my 'History,' which has reference to this subject:—"What, then, are the most significant features of the zoœcium for classificatory purposes? Form, superficial sculpture, the presence or absence of spines or other appendages, these are generally too variable and inconstant to yield any sure criteria. But we may find such in the structural peculiarities of the cell—as, for instance, the modifications of the *aperture*, the degree in which the primitive opening is preserved or obliterated,

* "La Faune des Bryozoaires Garumniens de Faxe," Ann. de la Soc. Roy. Malacologique de Belgique, tom. xxi. (1886). Mr. Walford has strangely misinterpreted the latter part of this passage and has given to one of its clauses a meaning the very opposite of that which the authors intended; see his paper on "Bryozoa from the Inferior Oolite," Quart. Journ. Geol. Soc. for August 1889.

the ribbed condition of the front wall (as in *Membraniporella* and *Cribrilina*), the chambered condition of the cavity (as in *Steganoporella*), &c. One of the most constant features of the zoœcium, too, is to be found (as noticed long ago by Hassall) in the orifice, which exhibits a series of well-marked modifications, and has in some cases a developmental history, which affords the most valuable, because the most significant, characters" *.

In point of fact a very considerable proportion of the Cheilostomatous genera which I have constituted or adopted are not based on "the form of the orifice." The following may be instanced in addition to those referred to in the above passage:—*Siphonoporella*, a Membraniporidan form characterized by a calcareous tubular structure attached to the lamina immediately below the aperture; *Euthyris*, also Membraniporidan, based on the structure of the operculum, which marks a distinct advance upon the typical *Membranipora*; *Micropora*, *Smittipora* (Jullien), *Thalamoporella*, *Setosella*; *Microporella*, founded on the form of the orifice in combination with the "special pore;" *Porina*, *Anarthropora*, *Mastigophora*; *Aspidostoma* and *Rhynchopora*, both based on the remarkable structures connected with the orifice, not on the mere form of it; *Stolonella*, allied to *Beania*, but having the membranous front-wall of the boat-shaped zoœcium protected by modified spines, which are united so as to form a continuous covering. Others might be added, but these are amply sufficient to show that, although in certain leading groups the stress has undoubtedly been laid on the form of the orifice, as being at once the most stable and significant character at present available, there has been no intention of basing the classification generally (as in the old zoarial systems) on a single character.

As to the zoœcial orifice, I believe that it has an intrinsic systematic value, and will probably always hold a distinct place as one of the criteria of affinity. In those sections at least of the Cheilostomata in which the oral opening has lost the primitive simplicity of the Membraniporidan type and is closed in by a solid frame, in which a well-organized operculum works on a distinct hinge, this structure has an undoubted significance of a very high order. Smitt, after an elaborate study of the modifications of the zoœcial orifice and the relation between the principal forms of it, felt himself justified in assigning it the foremost place as a generic character. Even Jullien, who makes the "front-wall" the corner-stone of his system, admits the significance of the oral

* Hist. Brit. Mar. Pol., Introduction, pp. cxxix, cxxx.

opening as a generic distinction and gives it a prominent place in his diagnosis. Koschinsky, in his very valuable paper on the Cheilostomata, gives it as his opinion emphatically that the form of the orifice is one of the most constant and available characters for classificatory purposes :—" Sehen wir von diesen und einigen anderen Fällen ab, so erweist sich die Form der Mundöffnung immerhin als eine der constantesten und brauchbarsten Merkmale " (*op. cit.* p. 9). Waters (Supplementary 'Challenger' Report, p. 3) has the following :—" Much has lately been written about classification, and some very unfortunate and premature attempts have been made at remodelling ; established genera have been rechristened, and generic names given where it has been doubtful if specific were required. . . . . As to my own position, I have repeatedly stated that, as far as the Cheilostomata are concerned, I consider an immense advance was made when the zoœcial characters were put in the first rank, and believe that we are upon the right track ; but none of us can suppose that there will not be much to alter as new facts are brought to light." I quite concur in these remarks. We are feeling our way as yet ; but I believe, with Mr. Waters, that " we are on the right track," and that we shall more surely reach our goal by the patient accumulation of facts and the careful study of their significance than by premature and revolutionary change.

I have already quoted the passage in which Pergens and Meunier refer to the variability of the orifice in many species, and have pointed out the error into which they have fallen in supposing that there has been any intention of substituting a single-character classification of any kind for the old system founded on colonial form *.

As to the alleged variability, there are no doubt cases in which differences of greater or less importance occur within the limits of a species. Some of these I have already pointed out elsewhere ; but, so far as my experience goes, there is nothing exceptional in the amount of variability which occurs

* Jullien also implies that the classification adopted by Smitt and (with modifications) by myself rests on " the form of the orifice " ('Note sur une nouvelle division des Bryozoaires Cheilostomiens,' p. 2). It does, of course, rest in part on this character and on the general structure of the orifice, but by no means as a whole. We have recognized a high significance in this character, but we have never proposed, so far as I know, to imitate the error of the older systematists, and base our system on a single structural feature. In a certain number of genera undoubtedly it has been made *the* diagnostic ; but this, as I have already explained, is simply because no other character of equal significance, or, indeed, of any special significance at all, could be found at the time.

in the zoœcial orifice. Such appears to be Dr. Koschinsky's opinion. Smitt, from the use which he makes of this character in his classification, must have found reason for believing in its general constancy as well as in its significance. Granting a certain amount of variability, it is only what we might expect, for variability in greater or less degree is met with in every element of organic structure, and supplies the material, as we know, with which natural selection works in the evolution of new forms. It would be strange if any form of structure were free from variation; but in the case before us, so far as my observations enable me to judge, there is, as I have said, no special instability, but, on the contrary, a remarkable constancy.

In my 'History of the British Polyzoa' I have carefully noted the "range of variation" for a large proportion of the species. An analysis of the observations recorded under this heading will show that the zoœcial orifice is one of the most stable structural elements and that the amount of variation which it actually undergoes is for the most part trifling both in amount and significance. Of course this remark applies to the adult primary orifice.

In some species (belonging to various genera) there is a difference which may truly be called remarkable between the orifice of the ordinary and that of the ovicelligerous cells. Before an oœcium has made its appearance in the colony our attention is arrested by the presence of two dissimilar classes of zoœcia, in one of which (the less numerous) the orifice is not only of abnormal size, but of equally abnormal form. The latter will in time bear the ovicells and is modified with a view to this function. We have good illustrations of this peculiarity in *Cribrilina clithridata*, Waters, and *Schizoporella longirostrata*, Hincks. Of course this is not a case of varietal difference; the diversity of form is a specific character and for a special purpose. It is quite possible, however, that in the absence of the oœcia this twofold structure of the cells might be misinterpreted, and might be classed as one of the "remarkable differences" which go to prove the instability of the characters of the orifice; and I have therefore thought it well to direct attention to it here *.

* Smitt has noted the occurrence (in *Escharella rostrigera*) of larger zoœcia amongst the ordinary ones, exhibiting a great difference both in the form and size of the orifice. Oœcia, as far as he could see, were totally wanting, and he was unable to determine the physiological significance of the difference. We can have no doubt, with our present knowledge, that the larger zoœcia with the modified orifice were the zooids destined to bear the oœcia.

Dr. Jullien, in his paper on the "Costulidées" and his Cape-Horn Report, takes his stand on Smitt's fundamental principle. He thus defines his position:—"La classification que je me propose de suivre . . . . a pour base fondamentale les caractères tirés de la *zoœcie* isolée, depuis son origine jusqu'à son extrême vieillesse" *. He proceeds to show that most of the recent writers on the Polyzoa (amongst whom he includes Busk, Smitt, Hincks, MacGillivray, and A. W. Waters) have followed the evil example of d'Orbigny, whilst giving their nominal adherence to the zoœcial principle of classification. They have adopted the principle, but have been unable to recognize or weak enough to ignore its legitimate consequences. As an illustration of their inconsistency he refers to their treatment of the genera *Cellepora* and *Retepora*, which they retain as originally founded on merely zoarial characters.

Now Busk, it may be remarked in passing, never professed to deal in any serious way with the revision of the classification, the importance of which he must nevertheless have fully recognized. The descriptive portions of his 'Challenger' Report must have severely taxed his energies at his advanced age, and before it was concluded he had to bear the additional burthen of declining health. It is true he adopted and introduced into his work certain portions of the new classification; but rather, it would seem, in deference to the prevalent feeling in its favour than as the result of any independent and comprehensive study of the questions at issue. He would certainly have been the first to admit that his 'Report' does not embody a *consistent* system, and might probably have added that circumstances did not admit of his attempting to frame one. Its value lies in the extensive and accurate diagnosis and delineation of specific forms which it embodies, a kind of work which, in the present state of our knowledge, is of peculiar and primary importance.

As to the charge of inconsistency and want of thoroughness in giving effect to the fundamental principle of the new system on the part of those who introduced it, it may be admitted at once that there is a certain amount of truth in it. Under the peculiar conditions of the case I venture to think that this may be easily explained and was but natural. Indeed, it could hardly have happened otherwise.

The early application of new principles which contravene established modes of thought and strike at the root of venerable systems is apt to be somewhat hesitating and to savour more or less of compromise. Much of the pioneer work in

* 'Mission du Cap Horn, Bryozoaires,' Introduction, p. 1.

such cases will be largely tentative in character. The full consequences of a new principle are not apprehended all at once, nor is it easy to cast off on the instant the yoke of old opinions, even when their foundations are shaken. All this is in the order of nature. It must be remembered, too, that there were serious difficulties in the way of arriving at a definite decision on many points at a time when the new systematic views had not as yet been thoroughly discussed nor their full significance appreciated. It seems to me, I confess, hardly just to make the hesitating step of those who were entering an untried region, and were unable to comprehend fully at first all the new conditions with which they had to deal, a matter of reproach. Their work has no doubt been a progressive one and has resulted in a much fuller and more thorough application of the new principle than they had realized at first. And I am far from denying that there are still oversights to be rectified and inconsistencies to be cancelled. Dr. Jullien finds one of the chief grounds for the charge of inconsistency which he brings against many of the later writers on the Polyzoa in their retention of the genera *Retepora* and *Cellepora*—artificial assemblages of species which, according to the new views, have no claim to be maintained. It is quite true that in my 'History' I have retained both these genera; but it is also true that in the case of *Retepora* I have pointed out the inadequacy of the fenestrate structure of the zoarium as the basis of a genus *, and, remarking that the zoœcial characters of the British species are similar, have left the rest of the group to be dealt with after a fuller study of foreign species than was then possible. As to *Cellepora*, in retaining it I did so on the ground that there were *zoœcial* characters on which it might be founded. This opinion I have long since abandoned; but neither time nor opportunity has been available so far for the exhaustive examination of the numerous forms which have found a place in the Celleporine group, on which alone a reconstruction could be founded. The genera *Retepora* and *Cellepora* I regard, and have long regarded, as merely provisional.

* "The reticulation is merely a form of ramification, and is probably entitled to no more systematic weight, apart from the characters of the zoœcium, than the simple branching, which was the distinction of the old genus *Eschara*. The retiform zoarium is associated with very different types of cell, whilst, on the other hand, a form in my possession . . . which cannot be distinguished generically, in other respects, from many of the *Reteporæ*, exhibits no trace whatever of reticulation. . . . . Strongly marked as is the facies which its peculiar habit of growth gives to the Retepore, we must not assign too much weight to it as a clue to natural affinity." (Hist. Brit. Mar. Pol. i. p. 389.)

Professor Smitt, in his later writings, has dismembered them and distributed the species with which he deals amongst other groups *.

After all, however, it matters little that the early expositors of the new systematic views did not see their way as clearly at first as they did subsequently. It may be admitted that they did not at once entirely renounce the principles "dont leur jeunesse a été impregnée" (*Jullien*); but this will hardly be held to justify the summary way in which Dr. Jullien rejects their authority and supersedes their work. In the new classification of the Cheilostomata which he has proposed the whole of the existing families have disappeared with two exceptions †; the familiar names which have long held a place in the literature of the class have been swept away and a new coinage has taken their place.

This step, to say the least of it, must be accounted premature, and in the interest of science I venture to think is to be regretted.

Dr. Jullien himself has entered upon a course of investigation which may throw light on the minute structure of the Polyzoa and possibly on the true basis of a natural system. His interesting studies of the anatomy of the Cheilostomatous forms may be expected to disclose the significance of structural elements of which at present we know but little, and so guide us in our search for the evidences of natural affinity. It would certainly have been more satisfactory to receive from him a new system at the close of an extended course of such research rather than in its early stages.

Pergens and Meunier have emphasized the importance of anatomical and embryological research as a means of arriving at a natural classification, and are of opinion that the able investigators who have followed these lines of study have failed so far to solve the problem, because their researches have stopped short at the formation of the primary zoœcia. It may be so, but it is more probable that such studies may throw light on the affinities of the Class and the true basis of its higher divisions rather than on the constitution of family and generic groups, which must rest chiefly on the more apparent zoœcial characters.

* Comparing *Escharoides rosacea* and *Retepora marsupiata*, he places them both in the same genus, and remarks:—"The difference in the form of the colonial growth cannot be of any generical value" (Flor. Bryoz. pt. 2, p. 68). I can find nothing to substantiate Dr. Jullien's statement respecting Smitt ("Note sur une nouvelle division &c.," *op. cit.* p. 2) that in his work on the Floridan Bryozoa "he relapses into the old errors."

† The Ceidæ of d'Orbigny and Æteidæ of Hincks.

Dr. Pergens has recently published an important paper* containing the results of his anatomical and developmental studies at the Zoological Station, Naples. He has had the opportunity of examining a large number of species with all the modern aids and appliances, and the paper is a valuable contribution to our knowledge of the Polyzoa. We are promised a continuation of it, which will be awaited with much interest. So far the results obtained do not appear to throw much new light on systematic questions; but if the observations recorded may be trusted, and they have evidently been made under the most favourable circumstances, with all care and full command of the newer methods of research, they will exclude several of Dr. Jullien's interpretations of structure, and notably his view of the nature and origin of the so-called pores in the cell-wall, which plays an important part in his proposed classification.

It would be impossible to examine the details of this classification within the limits of the present paper; but in the second section of it (on the *Cribrilinidæ*) I shall refer to the conception of the systematic significance of the zoœcial front-wall, on which it is largely founded.

I pass on to consider briefly Dr. Jullien's strictures on another case of supposed departure from the true principle of zoœcial classification. Some years since I instituted the genus *Barentsia* for the reception of a Pedicelline form, characterized by the concentration of muscular tissue at the base of the peduncle, as in the *Pedicellina gracilis*, Sars. Dr. Jullien contends that this genus is founded on zoarial and not, as it should be, on zoœcial characters, and has therefore no claim to acceptance. Accordingly he disallows it, and restores the species which have been ranged under it to *Pedicellina* †. I venture to think that he has committed himself to a hasty judgment in this case, which he will find it difficult to maintain.

The distinctive character of the genus *Barentsia* is the remarkable modification of the muscular apparatus and the structural change in the peduncle which it involves.

The question at issue turns on the interpretation which we put upon the so-called "stem" or peduncle of the *Pedicellinidæ*. In my view it is not an element of the zoarium at

* "Untersuchungen an Seebryozoen," Zool. Anzeiger, nos. 317 u. 318 (1889).

† "Aussi je n'admets pas la classification proposée par Th. Hincks pour les Pédicellines: les genres en sont établis non sur la forme de la zoœcie ni sur les caractères zoœciaux, mais sur le pédicelle de la zoœcie" ('Mission Sc. du Cap Horn,' p. 6).

all, but an integral part of the zoœcium. Dr. Jullien, in the passage quoted below, speaks of it as something absolutely distinct from the zoœcial structure; but he must have forgotten the investigations of Salensky*, Vigelius †, and others, and the conclusive evidence afforded as to its morphological significance by the relation which has been demonstrated between it and the "*Pedicellina*-cup" or "crown." As Vigelius has clearly shown, the *Pedicellina*-cup is not the mere "equivalent of a polypide," but "the homologue of a 'polypo-cystide,' of which the stalk constitutes an integral part." He adds:—"In ähnlicher Weise habe ich auch den Körperbau von *Barentsia* aufgefasst." It is quite unnecessary to repeat here the admirable demonstration of the homologies upon which this interpretation of the Pedicelline structure is based, which we have from the authors to whom I have just referred. Their writings are accessible to the student of the Polyzoa. It may be added that Nitsche, who adopted a somewhat different theoretic view of the Pedicelline cup, was prepared to regard the peduncle (and also the stolon) as homologous with the zoœcium of the Ectoprocta. Long ago Allman ‡ anticipated to some extent the conclusions of recent investigators respecting the nature of the peduncle, regarding it as homologous with the posterior part of the cell in the unstalked forms of Polyzoa. His prevision is sustained by the results of the later research.

The genus *Barentsia*, then, is founded on distinctly *zoœcial* characters, and as representing an important modification of the Pedicelline type has every claim to a place in our system. If its validity is challenged it must be on different grounds from those on which Dr. Jullien relies.

As I have remarked in a previous portion of this paper, there is hardly any serious difference of opinion now as to the true *basis* of the classification of the Polyzoa, although we have not yet determined with certainty the most significant elements of the zoœcial structure, as indications of genetic affinity. We have reached a stage, as it seems to me, in which there is need not so much of large schemes of reconstruction as of patient investigation and the quiet accumulation of data, which sooner or later must open the way for us to a true apprehension of the order of nature. Meanwhile

* "Etudes sur les Bryozoaires Ectoproctes," par M. Salensky, Ann. d. Sc. Nat. 6ᵉ sér. Zool. t. v. (1877), article no. 3.

† 'Die Bryozoen, gesammelt wahrend der dritten u. vierten Polarfahrt des Willem Barents, in den Jahren 1880 u. 81,' von Dr. W. J. Vigelius, pp. 89, 90.

‡ 'Freshwater Polyzoa,' p. 22.

there is no doubt room for critical revision of the details of the current classification and for such readjustment as may be rendered necessary by our increased knowledge of specific forms and may tend to make it a more complete expression of its fundamental principle. And I may say in passing that I am very sensible of the service which Dr. Jullien has rendered by his enthusiastic and uncompromising loyalty to that principle, though I am unable to accept the special scheme of classification which he has associated with it.

To Dr. Koschinsky we are indebted for a valuable critique on a number of Cheilostomatous genera, in which he suggests some modifications of the existing groups and constitutes a number of new ones.

Some of the changes which he proposes seem to me to be in every way worthy of consideration. The enormous increase in the number of described species within the last few years would alone render some revision of the genera absolutely necessary. We are now in a much better position for determining the precise value of the characters employed in diagnosis, and have a much larger knowledge of the modifications of the generic types. A group which might seem sufficiently isolated and distinctive, when represented by only two or three species, in which the diagnostic characters are clearly and strongly marked, will present a very different aspect when it includes a multitude of forms, amongst which the common characters may have been more or less obscured and variously affected by ceaseless modification.

As our knowledge widens the lesson is pressed upon us with added force that we cannot isolate plots of the great genealogical network and shut them up within hard-and-fast lines, but must be content with a large amount of indefiniteness in our system, in view of the infinitely varied and complex relationships of organic life.

While I am unable to accept all Dr. Koschinsky's criticisms, I freely admit that there is much force in many of them and that he has established a case for the reexamination and revision of some of the existing groups.

Section 2. Family **Cribrilinidæ**, Hincks.

Syn. Fam. *Costulidæ*, Jullien, Bull. Soc. Zoologique de France, t. xi. (1886).

In his paper entitled "Les Costulidées, nouvelle Famille de Bryozoaires," Dr. Jullien proposes a new classification of the forms which have hitherto been ranked in the family *Cribrilinidæ*, Hincks, including the genera *Membraniporella*, Smitt, and *Cribrilina*, Gray. He contends that this family has no claim to stand, as it is incorrectly defined (" mal définie "), and accordingly he has cancelled it and substituted for it his family Costulidées, from which, as he defines it, the genus *Membraniporella* is excluded. The capital error therefore in my definition of the Cribriline family, according to Dr. Jullien, is that I have made it wide enough to contain the latter genus. For this he condemns and abolishes it.

Now even if his view were correct, which I hope to show that it is not, it is more than questionable whether there would be any sufficient ground for displacing a well-established family name and adding a new one to our already overburthened nomenclature. Usage is certainly against the course which Dr. Jullien has taken; and though the common practice may not be absolutely the best, it may be wiser to recognize it than to unsettle our nomenclature and enlarge the wearisome synonymy which is the reproach of systematic natural history. In the present case, if Dr. Jullien's view were correct, the retention of the family with an amended diagnosis, accompanied by a proper notification of the change, would do no wrong to the author of it and would certainly be in the interest of the student*.

But it is unnecessary to discuss this question here, as I am not prepared to admit that the genus *Membraniporella* is an alien in the Cribriline family. Dr. Jullien refers it to the *Membraniporidæ*. He says, " Cependant les *Membraniporella* sont encore des Membraniporidées, toutes leurs espèces n'ont pas leurs épines absolument soudées sur la ligne médiane de la zoœcie : ce qui les différencie énormément des *Cribrilina*, où la soudure est non seulement complète sur la ligne médiane, mais où on voit encore de petits trabécules, qui soudent entre elles les épines principales. Les *Membraniporella* sont les Membraniporidées les plus élevées, et ne doivent peut-être pas être détachées de cette famille " (' Les Costulidées,' pp. 1, 2).

Upon this I remark first of all that I cannot assent to Dr. Jullien's statement that there are species of *Membraniporella* in which the (modified) spines are not soldered together along the median line. The type of Smitt's genus is *Membrani-*

* In support of his view Dr. Jullien has adduced an aggravated case in which names have been changed and misapplied in defiance of all law and custom (' Mission Sc. du Cap Horn,' Bryoz. p. 4). For such there is nothing to be said. But to deal with such cases and others of the same class, and to revise our system in harmony with Dr. Jullien's dictum, " un genre doit rester tel qu'il a été établi par son auteur," would be to revolutionize the nomenclature of the Polyzoa, and it is more than probable that we should find the cure to be worse than the disease.

pora nitida, in which the extremities of the ribs are closely and permanently united, so as to form a distinct median line. This is an essential character of the only genus *Membraniporella* which we know, and it is an essential character of the Cribriline family. Forms in which it is wanting must be placed elsewhere.

Dr. Jullien regards the *Membraniporellæ* as the highest of the *Membraniporidæ*; to me they are the lowest of the *Cribrilinidæ*. Let me say at once, however, that I am in perfect agreement with him when he urges that the true *Membraniporæ*, *Membraniporella*, and the *Cribrilinidæ* are forms which "s'enchaînent et pourraient à la rigueur ne former q'une seule famille." No doubt they are terms in an evolutional series, connected by many transitional links, and on merely genealogical grounds might well be gathered into a single group. But the question will arise, Why should we stop here? for we shall probably find that the group is not an isolated thing, but touches other groups at many points, and that the family relationship is wide and far-reaching. If we are to have any *system* at all embracing a number of limited groups the latter must represent the more marked stages in the evolutional process, the new structural departures, as it were, and the boundaries traced around these groups must be treated rather as imaginary lines, drawn for the sake of convenience, than as actual and abiding partition-walls *. For always and in all directions our "distinctive characters" will be gradually changing their aspect and significance, according to the method of nature. Only in this way can we make our classifications correspond with the actual plan of organic life. The Cribriline family, in my judgment, has been rightly constituted to represent an important morphological advance in the Membraniporine tribe.

Now if we examine this tribe, we find in the first place a series of forms (genus *Membranipora*) in which the zoœcial aperture is wholly closed in by the primitive membranous covering, and there is no trace of a calcareous front-wall; in some cases the margin of the aperture bears a number of spines or spinules, which may possibly have to some extent a protective function, in others the spines are more massive and bend in over the aperture, so as to form a rude kind of roofing. In some species they are altogether absent. The

* "In all our classifications of a truly natural group, where the different species will be arranged into more or less complete series, we must be prepared for seeing the limits between the divisions fading away, especially when the developmental changes are known." (Smitt, 'Floridan Bryozoa,' part 2, p. 41.)

orifice, through which the polypide issues from its cell, is a simple semicircular opening in the membranous wall, which is closed by a movable valve.

In another section we meet with an important modification and adaptation of the spinous appendages, resulting in the formation of a true roof-like structure, which gives a new character to the zoœcium and marks a great advance upon the slight protection afforded by a number of isolated spines. The spines are now represented by broad flattish ribs, which bend in over the aperture, those on each side meeting in the centre of the cell, where their free extremities are firmly soldered together. Laterally they remain separate, and the fissures between them are filled in by the primitive membranous wall. This group is the genus *Membraniporella* of authors. In it a well-framed protective covering, in great part calcareous, has been superadded to the simpler structure of the true *Membraniporæ*—a most significant morphological advance.

If we proceed a step further we find that in other kindred forms the ribbed front-wall is strengthened and consolidated by the addition of small lateral offsets (calcareous) from the ribs, which stretch across at short intervals from one to the other, and so bind them together and strengthen the fabric. The spaces between these intercostal supports are usually occupied by a line of pores. The genus *Cribrilina* has been founded for this well-marked structural type; and the two last-named genera constitute the family *Cribrilinidæ*, as I have defined it, of which the distinguishing character is that the zoœcia possess a ribbed calcareous front-wall, more or less consolidated, a character which has no existence amongst the true *Membraniporæ*.

Dr. Jullien, as we have seen, affirms that the genus *Membraniporella* includes species which have a calcareous front-wall and others in which the marginal spines are not absolutely soldered together on the median line ('Costulidées,' p. 1). On what characters then, we may ask, is the genus founded, and by what criteria is it distinguishable from *Membranipora*? By admitting that species which have the spines thoroughly united along the median line may mingle in the same group with others in which they are not "absolutely" united (that is, I presume, not really united at all), he virtually destroys the foundation on which the family *Cribrilinidæ* has hitherto rested. What remain, then, as the distinctive features of his own *Costulidæ*? The ribbed calcareous front-wall is also a character of his Membraniporidan genus *Membraniporella*. The small processes ("trabecules") given off from the sides of the ribs, and binding them one to the other, form in fact the only distinguishing character of the group. It is hardly necessary to say that, however interesting as a step in the development of the front-wall, this detail has no special significance and certainly no claim to be adopted as the basis of a family group.

But, as I have pointed out before, the genus *Membraniporella* is founded on a well-marked type-form, *M. nitida*, Johnston, in which the spines are transformed into ribs and are no longer isolated, but elements of a well-compacted protective covering, which roofs in the front of the cell. It is at this point in the evolutional series that a new family may be legitimately instituted, not to break the natural continuity of development or obscure the natural relationships, but to mark the morphological advance.

I am compelled therefore to reject Dr. Jullien's proposed change and to maintain the family *Cribrilinidæ* as at present constituted.

It must be remembered that the front-wall in this group is by no means homologous with the front-wall as it exists in most of the Cheilostomatous families. Its mode of growth is different, its constituent elements are different. It is not a continuous extension of the cell-wall, but is formed by the adaptive modification of certain spinous processes which originate on the wall below the margin of the cell. Its function, like that of the solid covering characteristic of other families, is protective, but the two are built on different structural plans and bear different relations to the zoœcial organism. A clear indication of this important fact should be included in the diagnosis of the family.

In the course of a careful study of a large number of Cribriline species which I have lately made one or two interesting points have been determined, which may be briefly noticed :—

i. *Modification of the Spines.*—In the early stages of the Cribriline cell the marginal spines, which are to form the front wall, present the same appearance as the corresponding parts in a *Membranipora*.

They are (in *Membraniporella nitida*) slender and suberect, but ultimately bend in over the aperture, and increase considerably in width by the secretion of calcareous matter round the edges. In this way a broad flattish rib is formed, in the centre of which the original spine is traceable. This transformation of the spine is constant throughout the family.

ii. *The Orifice and Operculum.*—The orifice amongst the *Cribrilinidæ* is formed by the two uppermost ribs, which are often stouter than the rest and which shut off and enclose the terminal portion of the aperture. It is not therefore strictly homologous with the orifice of the other Cheilostomata, which is due to an arrest of the calcification of the front-wall.

There is some variation in the position and character of the two ribs which close in the orifice. In *C. crassicosta*, Hincks *, two large stout spines originate one on each side at the top of the cell, and bend round to the front, in the centre of which they unite, inclosing a space of which the cell-wall is the upper boundary. These spines are usually very broad and represent the peristome of the solid-walled Cheilostomata. More commonly the two uppermost ribs of the costate roof, which originate at some distance from the upper extremity of the cell, constitute the boundary of the orifice in front (the lower margin), whilst the cell-wall encloses it at the sides and top. These two marginal ribs are thick and solid, and at the central point of junction the extremities frequently project and give a mucronate appearance to the front of the orifice. This is often very marked, as in *C. annulata*, Fabricius, and *C. furcata*, Hincks. Sometimes these marginal ribs do not meet exactly, and not unfrequently they remain permanently disconnected; sometimes the extremities seem to exceed the required length and are forced outward; usually a small cleft may be detected, which marks the point of junction.

Dr. Jullien takes exception to my retention of those forms with a *quasi*-mucronate lower margin amongst the *Cribrilinidæ*, and considers that I am false to the principles on which my classification is founded in not removing them to the genus *Mucronella*. That I have not done so he seems to regard as an admission that the structure of the orifice is essentially a character of inferior value as compared with the front-wall of the zoœcium, which he has adopted as the most important for classificatory purposes.

I do not propose at present to discuss the validity of the mucronate margin in *Mucronella* as a generic distinction, but merely to point out that it is by no means the structural equivalent of the two ribs which close in the orifice of the *Cribrilinidæ*. The structures are totally dissimilar in their morphological significance. The occasional and variable prominence (for it is by no means constant where it occurs) in certain species of *Cribrilina*, at the point of junction of the ribs which compose the lower margin, and which is in fact

* This is a very distinct form from the St. Lawrence, characterized by having a small number of very massive ribs, which are separated by wide intervals. In this species the protective covering is reduced to a minimum. For description and figure see a paper on "The Polyzoa of the St. Lawrence," 'Annals' for March 1888, p. 216, pl. xiv. fig. 5.

the result of the junction, is not comparable with the solid mucronate rising of the margin (itself an integral part of the cell-wall) in the *Mucronellæ*. I am perfectly justified therefore in not assigning a like systematic value to structures which differ entirely in their origin and their relation to the other elements of the zoœcium, and which have really nothing essential in common.

At the same time in the family *Cribrilinidæ* I regard the structure of the front-wall (or costate roof, as it may be called, to distinguish it from the front-wall proper) as the dominant character and much more significant than the orifice. It is the record of the evolutional changes through which the Membraniporine zoœcium has passed in one of the family lines, it tells the story of its gradual modification with a completeness that leaves little to be desired, and enables us to mark out a systematic group which is absolutely natural. But though we assign this rank to the unique protective covering of the Cribriline cell, it by no means follows that the ordinary Cheilostomatous front-wall is universally entitled to this distinction. The structure which replaces the latter amongst the *Cribrilinidæ*, as we have seen, is aberrant and exceptional and has a distinct evolutional meaning.

It remains to be proved that the solid calcareous covering which we meet with in other groups has any *special* morphological value or presents characters which are available for the purposes of the systematist. Dr. Jullien has certainly not supplied any evidence so far in support of his new view to which much weight can be attached. In fact his case rests mainly on the assumption (baseless, as I have just shown) that my treatment of the *Cribrilinidæ* is virtually a renunciation of the principles which I have hitherto maintained. If we add to this his contention ('Les Costulidées,' p. 3) that the fact of his having observed in different species monstrous cells, destitute of orifice but with "a superb front-wall," is a proof of his doctrine "que l'orifice est moins caractéristique que la paroi frontale," we have the whole case. This is certainly to base the primacy of the front-wall amongst systematic characters on a very slender foundation, and will hardly warrant such confident statements as the following:—"Des différents faits que nous venons d'énoncer il résulte que la forme de l'orifice est un caractère d'une valeur inférieure, dominé par celui qu'on peut tirer de la paroi frontale, et que les genres *Schizoporella*, *Lepralia*, *Mucronella* établis par Th. Hincks doivent être rejetés comme mal caractérisés" * ('Les

* After this condemnation it is somewhat startling to read the following passage in the Cape-Horn Report:—"Genre *Lepralia*, Th. Hincks

Costulidées,' p. 3); and again, "En établissant la famille des Costulidæ, j'ai fait voir la faiblesse du caractère principal adopté par Th. Hincks, pour sa classification des Bryozoaires Cheilostomiens, consistant simplement dans la forme de l'orifice zoœcial *, et j'ai établi la plus grande valeur caractéristique de la *frontale* (paroi). Cette appréciation m'oblige à rejeter tous les genres que l'auteur anglais a créé d'après la manière d'être de l'orifice, sans tenir compte de la disposition de cette paroi, et a bouleverser complètement les classifications admises jusqu'à ce jour. Je suis donc amené à définir de nouveaux groupements, pour l'établissement desquels je m'appuierai: 1e, sur la paroi frontale; 2e, sur la disposition des origelles; 3e, sur la forme de l'orifice; 4e, sur l'anatomie." ('Mission Sc. du Cap Horn,' p. 45.)

It is not my present purpose to examine at any length Dr. Jullien's scheme of a general classification of the Polyzoa †; but I venture to suggest that the time has not arrived for an efficient revision of our system and that the work of reconstruction (so far as it may be needed) should not be commenced until the foundations on which it is to rest have been thoroughly tested.

The dogma of the "front-wall," which Dr. Jullien would make the corner-stone of his new structure, has not yet been subjected to a searching examination. In his system it is associated with the theory of the "origelles," which must certainly be regarded, to say the least, as still *sub judice*, and upon which the researches of Dr. Pergens have already thrown considerable doubt. It would be impossible to accept the proposed system, whatever its merits may be, in the present stage of inquiry; and with all respect for Dr. Jullien I must hold that it is undesirable in the interest of science to sweep away existing classifications and unsettle established nomenclature and remove old landmarks until the foundations of the new order that is to follow have been well and securely laid.

(not Johnston, 1838), 1880. Cet ancien genre de Johnston a été entièrement bouleversé par Th. Hincks, et ne devrait plus exister aujourd'hui. . . . mais comme je comprends ce genre de la même façon que Hincks, je renvoie à sa définition." The genus is placed in the family Smittidæ, J. Jullien, the diagnosis of which is founded altogether on the structure of the zoœcial orifice.

* This statement may be somewhat misleading. It is no doubt true that in my classification the structure (rather than the mere "*form*") of the zoœcial orifice is a primary character; but in a large proportion of cases it is associated with other significant characters, and where it has been employed alone it has been from the absence (as it seemed at the time) of other available diagnostics.

† See 'Mission Sc. du Cap Horn,' p. 7.

To return to the *Cribrilinidæ.* The history of the operculum in its relation to the orifice in this family is worthy of notice. We can trace the passage from the simple Membraniporidan stage, in which the operculum is a membranous valve closing a semicircular opening in the primitive wall, to the fully developed chitinous door, fitted exactly into the oral framework and moving on a kind of hinge. Amongst the *Membraniporellæ*—the lowest of the *Cribrilinidæ*—there seems to be a very slight modification of the Membraniporidan arrangement. The operculum (in *M. nitida*) is formed of delicate membranaceous material and is not enclosed by the orifice, as in a frame, nor does it work upon the denticular processes which act as hinges in so many of the Polyzoa. When it is thrown back it is suberect and leans against the lower margin of the orifice, rising from the membranous wall, which is depressed and lies at some distance below the arched ribs. When it is shut it is enclosed above and at the sides by the cell-wall, but is nowhere in contact with the ribbed roof of the cell. It lies on the primitive wall, as in *Membranipora.* The same structure is met with in some of the *Cribrilinæ*, as *C. annulata* and *C. punctata*; but in most of the species which I have examined (as in *C. hippocrepis*) the operculum is composed of stout chitinous material, is closely fitted to the shape of the orifice, the base being in contact with the lower margin, and in the present case works on lateral denticles placed one on each side. We are able to trace in this element of the structure, as in the general character of the zoœcium, the progress of evolutional change from the lower Membraniporidan to the higher Cribriline type.

In his family of the *Costulidæ* Dr. Jullien has instituted no less than twelve genera, of which eleven are new, exclusive of the *Steginoporidæ* of d'Orbigny, which he rightly includes in this group.

Of these genera a large proportion, in my judgment, are founded on trivial characters of no special significance, and cannot be maintained. The characters drawn from the "front-wall" especially are generally of the very slightest moment, some of them hardly of specific value. Those drawn from the "pores d'origelles" can hardly be estimated until we are in possession of the results of further investigations, but are probably of very secondary importance.

I have already given my reasons for holding that *C. hippocrepis*, Hincks, cannot be detached from the Cribriline group, on account of the structure of its zoœcial orifice; but within this group I am inclined to agree with Dr. Jullien that it should stand as the type of a new genus.

This paper has assumed of necessity more of a controversial character than I could have desired. I trust that none of the evil spirit of controversy has found its way into what I designed to be a purely critical discussion in the interest of scientific truth.

XIII.—*On a new Species of Tit.*

Dehesa de Cólogan,
Puerto de Orotava,
Tenerife,
1st December, 1889.

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

GENTLEMEN,—I enclose you the description of a new species of Tit that I have just discovered in the island of El Hierro, the most southern and western of the Canarian Archipelago. It is abundant in the pine-forest there.

Yours faithfully,
E. G. MEADE-WALDO.

Parus ombriosus, sp. nov.

P. Paro teneriffæ similis, sed fortior et robustior; tergo toto olivaceo-viridescente, nec cæruleo; tectricibus alarum viridibus, majoribus angustissime albo terminatis: subtus citrinus, *P. teneriffæ* similis. ♀ haud a mari distinguenda.

Named from the ancient Moorish name (Ombrios) of the island of Hierro, where alone it has been found.

XIV.—*How does the* Ugimyia-*Larva imbed itself in the Silkworm?* By Dr. FR. MEINERT.

THE 'Bolletino della Società Entomologica Italiana,' anno secondo (1870), contains two papers concerning the *Ugimyia sericariæ.* One is a little note only ("Sull' insetto Ugi," pp. 134–137) by Rondani, mentioning the larva and pupa of a Tachenarian which Mr. Menegazzi had discovered in Japan making its way out from the cocoon of a silkworm. In conclusion Mr. Rondani (p. 137) gives a description of the larva and of the pupa, and, without knowing the imago, he classifies the animal as a new distinct genus and species —*Ugimyia sericariæ*. The other paper, a dissertation by Cornalia (*l. c.* pp. 217–227), gives an account of the imago, accompanied by figures exhibiting the animal in its successive stages of evolution. Prof. Cornalia further advances the theory that the fly in question, after the fashion of the common Tachinariæ, deposits its eggs externally on the skin of the silkworm, into whose inner organs the maggot then forces its way through the skin. Afterwards, before transforming itself into a pupa, the maggot again makes its way out from the pupa and cocoon of the silkworm.

Before, however, Mr. Rondani published his paper, the Secretary of the English Legation in Japan, Mr. Adams, had already given an account of this remarkable fly and its attacks on the silkworm ("Deuxième rapport sur la sériculture au Japon," Rev. univ. d. séricult. Lyon, no. 36, 1 avr. 1870 *). And in the interval between the publications of Rondani and Cornalia the same fly was mentioned by Guérin-Méneville under the name of *Tachina* (? *Phorocera*) *Oudji* in his "Observations sur la nature de l'*Oudji*, parasite des vers à soie au Japon, présentées à l'Académie des Sciences, dans sa séance le 17 avril, 1870" (Compt. Rend. lxx. p. 844; Rev. et Mag. Zool. 2 sér. tom. xxii. pp. 178–181). Besides, the matter has been touched upon by Prof. Westwood (Proc. Entom. Soc. Lond. 1870, p. xxii), by Mr. Haberlandt ('Der Seidenspinner'), and by Mr. Pryer, who, in his 'Catalogue of Japanese Lepidoptera,' mentions the *Uji* as an enemy of the silkworm, and, further, states that he "has noticed that the Uji . . . . deposits its eggs *about the larva on the leaves, and not on the insect.*" Unfortunately these three last-named papers have not been accessible to me.

The Ugi-plague, however, has been more thoroughly treated in Japan, its native country, than in Europe, and principally in an excellent paper by C. Sasaki, Rigakushi ("On the Life-history of *Ugimyia sericariæ*, Rondani," Journ. Sc. Coll. of the Imp. Univ. of Japan, 1886). But other Japanese savants, before Mr. Sasaki, have studied this fly, its habits, and its connexion with the silkworm. Twelve or thirteen years earlier, the father of the above author, Mr. N. Sasaki, commenced some investigations into the subject, stating that the larva or maggot of the *Ugimyia* was found imbedded in the main trunk of the silkworm's tracheæ directly under a

* The figures accompanying this paper are styled by Guérin-Méneville "suffisantes." Sasaki, however, deems them insufficient. I have seen neither the paper nor the illustrations.

stigma, from which he concluded that the maggot entered the stigma from the outside from eggs deposited by the fly on the mulberry-leaves. C. Sasaki does not tell us whether his father published these investigations; but very similar views and opinions are set forth by the anonymous author of the 'Review of the Japan Silk Trade for the Season 1873–74.' By the great courtesy of the Danish Consul-General at Nagasaki, Mr. de Bavier, I am able to quote at some length this Review, which is very rarely met with in Europe. The author writes (p. 6) as follows:—

"In the Third Report of Japanese Sericulture, dated Yedo, August 10th, 1870, Mr. F. O. Adams, First Secretary of the British Legation, summing up his previous researches on the subject, states that the larva of the Uji, after having fed upon the chrysalis and killed it, pierces the cocoon; that the cocoon thus pierced can neither be reeled, nor, of course, be used for reproduction; and that the proportion of cocoons containing Uji varies from 10 to 80 per cent. In the absence of all reliable information on the part of the natives, who seem to have paid no attention to the matter, he was led to surmise that the larva of the Uji must in spring transform itself into a fly, and that the fly deposited its eggs under the epidermis of the silkworm. . . .

"In order to put Mr. Adams's theory to the test of experiment we reared some silkworms in a room where every precaution was taken to exclude flies and other insects. The result was as follows:—

"312, say 50 per cent., cocoons pierced by moths.
"235, say 38 per cent., pierced by Uji.
"40, say 7 per cent., unpierced either by moths or Uji.
"33, say 5 per cent., double cocoons.

". . . . This was in 1873. . . . . In October some Uji on being cut open were found to contain the well-formed embryo of a fly. On the 3rd May we had the satisfaction of finding a number of flies which had emerged from the Uji prisoners under a veil of gauze arranged for that purpose; the empty shells of the larvæ were found in earth, where they had remained imbedded since their birth.

"The proportion of Uji, which, in spite of our precautions to protect the silkworms, we had found in our cocoons, was so startling, that we contrived this year to protect them still more efficiently than we had done the year before. The eggs therefore were hatched and the worms fed under a wooden framework provided with sliding doors and entirely covered with gauze. The windows of the room itself were closed with frames covered with the same material. The result was this :—

"275, say 31 per cent., cocoons pierced by moths.
"450, say 53 per cent., pierced by Uji.
"135, say 12 (?) per cent., unpierced by either moths or Uji.
"30, say 4 per cent., double cocoons.

"In the presence of these facts the theory that the fly of the Uji deposits its eggs under the epidermis of the silkworm must clearly be given up. Does, then, the fly lay its eggs on the mulberry-leaf? Is the food the vehicle by which the germ of the Uji finds its way into the silkworm's intestines?

". . . . To the kindness of a correspondent who takes a warm interest in the matter we are indebted for the following note :—'The fly of the Uji is the *Ugimyia sericaria* (sic), thus named by Rondani.'"

I may also quote what, according to Mr. C. Sasaki, Mr. G. A. Greeven writes in the 'Japan Times' of May 4th, 1878 :—"My experiments have now shown me that the hatching of the Uji takes place in the stomach of the caterpillar, and that it immediately forces its way through the membrane of the stomach and makes a path for itself to a stigma."

Mr. C. Sasaki commenced his investigations in 1883, and in the following year he communicated to the American periodical 'Nature' a short preliminary article, "*Udschimyia sericaria*, Rond., a Fly Parasite on the Silkworm" (printed 'Nature,' vol. xxx. pp. 435, 436), which two years afterwards was followed by the fuller account mentioned above. From this last-named treatise I shall try to point out the principal results obtained by Mr. Sasaki concerning the evolution of the *Ugimyia sericariæ* :—(1) The fly deposits its eggs on the under surface of the mulberry-leaves, generally at the end of May. (2) The silkworms being at this time of the year in their third or fourth stage of evolution, devour the eggs—often a great number of them—together with the mulberry-leaves. (3) The eggs remain from one to nine hours in the digestive canal of the silkworm, and the maggots having emerged from the double-shelled eggs, likewise remain there for from one to eight hours more before piercing through the walls of the canal. (4) Having pierced through the walls of the digestive canal, the maggots directly enter the abdominal ganglia and feed on the ganglion-cells. (5) Having devoured the ganglia, the maggots pass into the body-cavity of the silkworm, and, travelling through the mass of fat, they search for those portions of the tracheal system of their host where the stigmata open. (6) On reaching one of these places the maggot forms a sort of cup for the reception of its body by heaping up the fats and muscular fibres of its host, and sticking them together with its saliva. (7) At the bottom of the cup an opening is left, and through this opening the maggot resting in the cup maintains its connexion with the air, while through the mouth of the cup it is able to project its head into the abdominal cavity of the silkworm, on whose fat it is feeding. (8) The cup being formed, a dark brown spot appears on the silkworm's epidermis around the stigma, continuing visible on the pupa also after the transformation. (9) When fully developed the maggot forces its way out through the skin of the silkworm, or, if the worm has been transformed into a pupa, through the pupa and its cocoon. (10) Whereupon the maggot seeks the ground, and there, in a couple of days, it is transformed into a pupa. (11) The pupa remains in the ground during the winter, and in the middle of April or at the commencement of May the fly appears.

As will be seen, some of these points have already been settled by authors of earlier date; but to Mr. C. Sasaki belongs the merit of having stated them in a way meeting some objections which might otherwise have been advanced. Thus, for instance, regarding the question how it is possible for the eggs to arrive safely into the digestive canal of the silkworms Mr. Sasaki (*l. c.* p. 16) explains:—"That the eggs do not get hurt in passing into the body of the worm is further confirmed by comparing the size of the pieces of the leaves contained in the digestive canal with that of the egg. It will be found that the size of the former is many times that of the latter." Another question, why only one or two full-grown maggots emerge from a silkworm or cocoon, although the silkworm most frequently has been infested by a much larger quantity of the parasites, Mr. Sasaki explains in the following way (p. 17):—"This is due to two reasons: 1st, the silkworm, when infected by more than one maggot, dies from not being able to endure the injuries caused by these parasites, which then perish by a kind of suicidal death; 2nd, one among several maggots infesting the same silkworm may grow more actively and rapidly than the others, which will then die from the want of requisite food."

The development of the *Ugimyia sericariæ*, as related by Mr. Sasaki, is really deserving of attention, as involving so much of interest and so many surprising points. But still I could not believe in the correctness of all his assertions, and one of them especially seemed to me to be very little worthy of credit. I could not imagine that the point no. 6, concerning the formation of the cup and the maggot's connexion with the tracheal system of the silkworm, was in accordance with the real facts.

Therefore, deeming it possible to study these facts on specimens preserved in alcohol, I addressed myself to the Greek Northern Telegraph Company, and was met with the utmost kindness on the part of the Company's President, Mr. Tietgen. A short time afterwards I received from one of the officers of the Company, its Superintendent at Nagasaki, Mr. C. Kragh, a parcel containing, besides numerous maggots and some pupæ and imagines of the *Ugimyia*, also two specimens of the silkworm preserved in alcohol. One of these specimens was intact, but with a dark brown spot surrounding one of its stigmata; the other was cut open longitudinally, and a maggot was seen projecting its anterior end from the mouth of a sort of cup fastened to the inner surface of the silkworm's skin. I feel highly indebted to Mr. C. Kragh for his courtesy, and I beg to express my sincerest thanks.

In the first place I cut open the silkworm that was intact, and a half-grown maggot (its length being about 5·5 millim.) was found lying between the skin and the digestive canal of the silkworm. But as for the rest, nothing like a cup was to be seen, nor was the rear end of the maggot situated inside the stigma surrounded by the dark spot. On the contrary, the maggot was lying quite freely, as it were just moulded into the mass of fat, its head projecting about 1·5 millim. beyond the anterior edge of the dark spot, while its distance from the silkworm's skin was something like 2 or 3 millim. The rear end of the maggot certainly had approached one of the hindmost stigmata of its host; but the stigma in question was not situated in the centre of any spot, and no trace of a cup was to be found. Besides, a mass of fat covering the rear end of the maggot entirely closed the stigmata of the parasite.

Thereupon I turned my attention to the other specimen, with the body cut open and the maggot peeping out from the cup; but I soon observed that the maggot was glued to the bottom of the cup, a way of mounting, however, which in such preparations made for public instruction very often cannot be avoided.

This examination of the two silkworms not being sufficient to satisfactorily solve the question, I again addressed the Superintendent, Mr. Kragh, who had the extreme courtesy to send me a new supply of about a hundred cocoons with pupas enclosed, the majority of which were supposed to be infested by maggots. For sending silkworms the season was too far advanced.

Of these pupæ only a fifth, or, perhaps, a little more, were found to be in a normal condition, without any brownish spots, and not at all infested by the parasite. Among the rest something like a tenth part did not exhibit any spots; but nevertheless in each pupa a maggot was found, and in one specimen two maggots. However, though no spots were visible on these pupæ, a dark lump (of compressed tracheæ) was found constantly inside one of the stigmata, exactly as in the spotted specimens. Occasionally a pupa was found exhibiting brownish spots and having the dark lump inside a stigma, but without any parasite at all. Still I dare not deny that possibly a small maggot may have been overlooked by me, although I searched for it most carefully.

Generally the pupæ had one or more spots around one of the stigmata (in most cases one of the first pair of abdominal stigmata), and inside that same stigma the dark-coloured lump mentioned. The maggot was found occupying a place more or less in the midst of the abdominal cavity of its host, thoroughly imbedded in a white mass of fatty structure. Exceptionally two or more stigmata were surrounded by such spots; but then also two maggots, one considerably smaller than the other, were found inside the silkworm. Twice I found three maggots, one large and two smaller ones.

As to the position of the maggot inside the pupa, it was but rarely found to be in contact with either the tracheæ of its host or the stigmata, or with the dark-coloured lump, nor could I discover anything like a cup. As a rule the maggot was lying longitudinally in the middle of the pupa, having its mouth turned sometimes forwards, sometimes backwards. If two or three maggots were found the larger one held the central position, pressing the smaller ones towards the sides.

At length, having examined about fifty cocoons, I found a pupa in which the maggot was lying in a long sac, with its stigmata turned towards the bottom of the sac. The outer end of the sac, which really had some connexion with a stigma and with the epidermis of the silkworm, was of a brownish colour, while the inner part was whitish, much thinner, and cut off. Twice afterwards, in other specimens, I again found a similar sac containing the maggot. And, finally, I met with a pupa in which the maggot, as usual, was found located in the middle of the body, while from its bed a short canal led towards one of the pupa's stigmata, the walls of that canal being of a brownish colour at the outer end. The three or four cases just mentioned agree with the theory of Mr. Sasaki to a certain extent. In some important points, however, the distinguished Japanese savant may be mistaken, as I shall now try to prove.

The cup or sac is not, I should say, constructed by the maggot "by heaping up the fats and muscular fibres." It is merely a portion of the tracheal system of the silkworm swelled by the presence of the parasite and tinged brown by its excrement. Having forced its way into the trachea, the young maggot imbeds itself there, with its spiracle-plates turned towards the stigma of the silkworm and with its mouth peeping out from the trachea into the body-cavity of the host. By-and-by, as the maggot grows, the trachea expands and swells, its outer part assuming a brownish colour from the maggot's excrement, while the inner portion remains uncoloured. I therefore conclude that if a living or fresh silkworm infested by a maggot is cut open for investigation, the inner part of the trachea or sac, being thin and white, may break off, while the outer, brownish, part remains in connexion with the skin of the silkworm. *This last-mentioned brownish part of the trachea, then, is the "cup" of Mr. Sasaki.* By means of the microscope it may be clearly seen that the inner surface of the sac is formed exclusively by the inner membrane of the trachea, the tunica intima, and does not show any trace of muscular fibres or of fats. It is also observable that on the tunica intima of the main trachea forming the inner surface of the sac, as well as on the other adjacent smaller tracheæ, the brownish colour is more intense, while the muscular fibres and fats surrounding the sac are much less coloured. From the same source, viz. the excrement of the maggot, the dark spot on the silkworm's skin also derives its existence. That the sac is formed by the trachea is proved, moreover, by the fact that the mouths of the smaller tracheæ are easily distinguished on its inner surface.

As to the sticking-power of the colouring-fluid (excrement or saliva), it must be very slight indeed, or, rather, none at all; otherwise the sac or cup would adhere to the skin of the silkworm, and probably be thrown away, together with the cast-off skin, at its transformation into a pupa. But this is not the case: the sac remains inside the host, and constitutes the dark lump found behind the stigma of the pupa. With proper care this lump may be unrolled, and proved to be a sac large enough to embrace the maggot living in the body of the pupa. As will be remembered, the maggot was found three or four times still occupying such a sac corresponding to the lump.

In connexion with what is here stated, I shall call attention to the fact that those *Tachina*-larvæ that feed parasitically on insect-imagines * in a similar way occupy a sac formed by the trachea of the host (*conf.* Cholodkowsky, Zool. Anzeig. 1884, p. 316), a fact which I have had the opportunity of ascertaining myself when examining the maggot of *Tachina pacta* infesting a *Carabus hortensis*.

When therefore Mr. Sasaki says that the maggot of the *Ugimyia* occupies a cup, I agree with him to some extent, although I deem it more appropriate to style the "cup" a sac. But, in opposition to his views, I am of opinion that the maggot only for a time occupies that place and that it leaves it, sooner or later, in order to force its way into the central part of the body of the silkworm or of the pupa. At what time the maggot emigrates from its sac I cannot say precisely; I have had too few silkworms at my disposal. But this I can maintain, that the maggot is very seldom found in the trachea of the pupa, and that it is often very young when it leaves the sac, viz. in its second larva-stage, the length of such emigrated maggots being sometimes only from 3·8 to 4 millim. Perhaps this migration may be influenced by the moultings or the pupation of the maggot.

Having at my disposal a very great number of maggots, of every length from 3·8 to 14 millim., I had a fine opportunity for studying the evolution of the spiracle-plates. I have not seen the first larval stadium of the *Ugimyia*-maggot, viz. from its leaving the egg until its locating itself in the corpus adiposum of the silkworm, but I had before me the three following stages. In the second stadium the spiracle-plates exhibit only two short, broad, thin-skinned areas ("fissures"), while in the third stadium these areas are three in number, a little longer, somewhat narrower, and already of a rather angular shape. In the fourth (or last) stadium their number continues three; but they have become long and comparatively narrow, with curved outlines. In all stages I found that the spiracle-plates were closed, the so-called "fissures" were no fissures, and the respiration takes place through the thin-skinned areas of the spiracle-plates. This remarkable circumstance, however, perfectly agrees with the fact that the *Ugimyia*-maggots are found imbedded

* With other *Tachina*-larvæ, which force their way into the body of their host through its skin, the hypodermis of this skin forms the sac (*cfr.* Auth. Entom. Tidsskr. 1886, p. 191).

in the body-cavity of their host, without any communication whatever between the air of their tracheal system and the atmosphere. This state of things I have observed, however, not only in the *Ugimyia*-maggot, but also in maggots of other parasitical Diptera, of *Tachina*, *Lucilia*, *Hypoderma*, &c., the genus *Gastrophilus* alone making an exception *.

Summing up the results of my investigation, I come to the following conclusions:—(1) Mr. Sasaki is right, undoubtedly, in his opinion that the eggs of the *Ugimyia* find their way into the body of the silkworm through its mouth; and I should think that other caterpillars also are infested in the same way. (2) The *Ugimyia*-maggot for a while only is located immediately inside one of the silkworm's stigmata, and certainly does not form its bed "by heaping up fats and muscular fibres;" but the bed is a widening or swelling of the trachea itself. This fact is fully in accordance with what is known of the parasitical life of many *Tachina*-larvæ. (3) The plates of the spiracles or stigmata of the *Ugimyia*-maggot are quite closed, a fact that may be observed also in other *Musca*- and *Œstrus*-larvæ, the genus *Gastrophilus* alone excepted.

Copenhagen,
November 12, 1889.

XV.—*Description of a new Species of Dragon-fly.* By W. F. Kirby, F.E.S., Assistant in the Zoological Department, British Museum.

Dr. Karsch has lately pointed out, in the 'Entomologische Nachrichten,' that my *Fylla exigua* is apparently identical with *Nannophya pygmæa*, Ramb. I find that I had been misled by an old label attached to a pair of an undescribed genus and species in the British Museum. These I now describe, although they are without locality, as I have already described the genus and figured the neuration under the name of *Nannophya*, and this seems to be the readiest means of preventing further confusion. I think it probable that the specimens are from some part of the Malay Archipelago.

* For further information concerning the evolution of the spiracle-plates I may refer to a little paper, "Ugimyia-Larven og dens Leie i Silkeormen," which I am publishing in the 'Entomologiske Meddelelser,' Bd. ii. 1890, with some figures.

AINO, gen. nov. Libellulidarum.

Nannophya, Kirb. Trans. Zool. Soc. Lond. xii. p. 313 (1889), nec Ramb.

As this genus is fully characterized in the journal quoted the characters need not here be repeated.

Aino puella, sp. n.

Nannophya pygmæa, Kirb. (nec Ramb.), Trans. Zool. Soc. Lond. xii. p. 313, pl. lvi. fig. 7 (1889), neuration only.

Exp. al. 27–28 millim., long. corp. 17 millim.

Male.—Head and thorax clothed with rather long hairs. Face chocolate-brown, bordered above and on the upper part of the sides with ivory-white ; frontal tubercle bronzy green, and surmounted by a crest of black bristles, the face being clothed with shorter ones. Occiput black, shining, with two white contiguous dots behind the occipital triangle. Thorax pulverulent blue ; abdomen and legs black. Wings hyaline ; pterostigma rusty brown.

Female.—Head as in male ; thorax and legs reddish chocolate ; a V-shaped spot on the back of the mesothorax ; mesothorax with a yellow stripe on each side above and the greater part of the pleura yellow ; traversed obliquely by a chocolate-coloured stripe, connected in front with the dark colouring above and below, and swelling out into a large dark spot in the middle; abdomen black, with yellow bands, gradually diminishing, at the base of the first five segments above, and the appendages and the space between yellow. Wings tinged with yellow at the base as far as the triangles.

Locality unknown (Malay Archipelago ?).

BIBLIOGRAPHICAL NOTICES.

Notes on Sport and Ornithology. By His Imperial and Royal Highness the late CROWN PRINCE RUDOLF of Austria. Translated, with the Author's permission, by C. G. DANFORD. Gurney and Jackson.

MOST of those ornithologists who were familiar with the German language had read with pleasure the account of an excursion made by the Crown Prince along the Upper Danube in the latter part of April 1878, chiefly made known through his companions Dr. A. E.

Brehm and the late E. F. von Homeyer, while Prof. A. von Pelzeln was allowed to publish extracts from the narrative of 'Fünfzehn Tage auf der Donau,' printed for private circulation. In 1879 similar sketches were given of a recent visit to Spain and Portugal; 'Eine Orient Reise' followed, with a graphic description of a journey up the Nile to Nubia, and afterwards through Palestine; other articles, chiefly on ornithology, subsequently made their appearance, and finally all these papers were published in one volume. Mr. Danford, as a brother sportsman and ornithologist, was strongly impressed by the freshness and originality of the observations made by the young author, whose permission to translate the work was obtained, and the task, which was a labour of love, was already far advanced when the sad death of the Crown Prince took place. Mr. Danford's familiarity with many of the localities mentioned, as well as with the technicalities of natural history and sport, coupled with his knowledge of German, have enabled him to render the author's exact meaning and even to reproduce his vivacious turns of phrase with a fidelity which calls for our highest admiration.

Everyone will, we think, enjoy the description of the marshy low-lying woods of the Danube and their profusion of bird-life; while if the destruction of White-tailed Eagles, Vultures, Black Storks, &c. at their breeding-places seems too prominent a feature, it must be remembered that the nests to which the Crown Prince was taken were those known to the foresters and comparatively easy of access, whereas ten times as many lay hidden at some distance away from his route. In the Fruška-Gora, Homeyer shot a Griffon Vulture from its nest on an oak, the only instance with which we are acquainted of a tree being selected by that cliff-haunting species, though the Black Vulture, which was met with in the same locality, always nests in a tree. An interesting account is given of the remarkable antipathy felt by the "Stein" Eagles for the Black Vulture, which they attack on every possible occasion; from the description we are inclined to believe that the aggressors are immature Golden Eagles which, having as yet no domestic cares, employ their time in persecuting the Vultures. As regards the identity of the Pigmy and the Booted Eagles the Author's experience coincides with our own, and it is surprising that different views should have been entertained for so long a time in certain quarters.

The visit of the Crown Prince to Spain in 1879 was of brief duration, and some of the assertions set forth in this work must charitably be set down to inexperience. With regard to the distribution and numbers of the Bearded Vulture, a rude and flat contradiction is given to an ornithologist who had certainly passed more months among the haunts of that bird than the Crown Prince had spent days; and upon this point we may therefore quote the independent testimony of Lord Lilford, who is unrivalled for his acquaintance with birds of prey in all parts of the Peninsula:—"I have noticed this [the Bearded] Vulture in almost every province of Spain that I have visited. A pair are generally to be found breeding in the neighbourhood of every establishment of Griffons, and when the latter birds have picked the bones of a carcass bare, the Bearded Vultures come down and, swallowing the smaller bones, carry off the larger into the air, and, letting them drop from a great height upon the rocks, devour the fragments at their leisure." Moreover, not content with dwelling upon the supposed rarity of this species in Spain, the Crown Prince goes on to say that "in all high mountains, whether situated in Central or Southern Europe, Northern Africa, or Central Asia, it is very much the reverse [of common];" yet, on p. 566, he tells us that it still inhabits the Retyezát, Transylvania, "in considerable numbers"! The statement that the Spanish "Stein" Eagle is characterized by "a white tail tipped with black" is quite misleading, and can only apply to immature examples, for in adult Golden Eagles from Spain the rectrices are just like those in Scottish specimens. The fact is that in Spain the Crown Prince was forced, like everyone else in that country, to try and find things out for himself; whereas on the Danube and throughout the Austro-Hungarian Empire he was naturally a great personage, for whom everything was, to use a vulgar phrase, "cut and dried" by obsequious proprietors and foresters. In saying this we do not for one moment wish to detract from his merits as a sportsman and a naturalist, for he was undoubtedly both. He never shunned hard work, and the reader will be struck by his wonderful energy, keen enjoyment of wild life and scenery, and his exuberant animal spirits, these features being especially noticeable in the descriptions of the visit to the Danube, the journey to the East, and the sketches from Hungary, Transylvania, &c. On the whole the book is very interesting, though the style is somewhat wordy and monotonous, a fault which the translator was unable to rectify. For the rest, Mr. Danford has performed his task with great ability and is entitled to the thanks of all true naturalists; the general style of the volume is admirable, and the type is bold and clear.

The Fauna of British India, including Ceylon and Burma. Edited by W. T. Blanford. *Fishes*, by Francis Day. 2 vols. 8vo. London: Taylor and Francis, 1889.

About a twelvemonth ago we noticed the commencement of this valuable series of Handbooks of Indian Zoology, on the publication of the first part of Dr. W. T. Blanford's account of Indian Mammalia. As then indicated the task of describing the Fishes had been entrusted to Dr. Francis Day, whose great illustrated work, 'The Fishes of India,' was already established as the authority on this part of the Fauna of our Eastern Empire, and in the course of the year which has just terminated the two volumes devoted to the class Pisces have made their appearance. These volumes must be regarded with a somewhat melancholy interest not only because they are the last records of a life, many years of which were zealously devoted to the study of the subjects of which they treat, but also from the consideration that the author did not even live to witness the publication of the results of his labours. Before one half of the first volume had been printed Dr. Day was so ill that he could no longer take any part in seeing his work through the press, which was consequently thrown entirely upon the Editor; and he died within a very few days of the publication of the first volume.

So far as the book is concerned, however, under the careful and conscientious editorship of Dr. Blanford, intensified no doubt by the feeling that special care was requisite in dealing with the orphaned work of a deceased friend, it has probably suffered very little by the untimely death of its author. Of its interest to the zoologist there can be equally little doubt. It contains the characters of over 1400 species of Indian fishes*, and as these consist to a great extent of forms ranging on the one hand from the Red Sea and African coasts, and on the other from Japan and the Pacific, to the Indian region, it embraces a most interesting and important series of forms. From another point of view the great number of Indian freshwater fishes, many of them with marine affinities, first made known to European zoologists by Hamilton-Buchanan some seventy years ago, are of great interest, and to the number of these Dr. Day has by his own researches made considerable additions.

As to the mode in which the work has been carried out there is little to be said. From the great number of species to be described it was no doubt impossible to introduce statements as to their natural history, such as Dr. Blanford was able to incorporate in his account of the Indian Mammals, and indeed it is probable that in the case of Fishes there was comparatively little to be said. But the short descriptions seem to be carefully drawn up, the groups, families, genera, and species are tabulated throughout, and as a guide to the determination of the species here recorded the book leaves little or nothing to be desired.

There is, however, one point to which we would call attention, as we think it marks a serious defect in an otherwise excellent book. The synonymy of the species and genera is very imperfectly given, and in most cases the reader is referred for information upon this point to the author's 'Fishes of India.' To the collector wishing to ascertain the names of his specimens this is of little consequence, but to the student of Ichthyology it is a very different matter. For all the higher purposes of systematic Natural History a knowledge of synonyms is indispensable, and it will be a great disappointment to the student to find that to obtain this in the present case he must refer to another book which perhaps is not within his reach. Of many species with a very wide distribution it may safely be predicated that they have been several times described under different names by authors who have had to deal with collections from particular localities, and under such circumstances the absence of

* This number has been considerably increased by the numerous marine species noticed and described by Dr. Alcock in his interesting papers published in the last two numbers of this Journal.

all indications of the synonymy becomes a very serious defect. We do not mean that in a work like the present anything approaching a full synonymy could be given, but two or three of the synonyms of most importance, especially from a distributional point of view, would have added enormously to the value of the work.

Apart from this, however, the present work must be regarded as a most valuable contribution to the literature of Ichthyology. The species, as already stated, are all tabulated, and further they are described with quite sufficient detail to enable them to be readily identified; of a great number excellent woodcut figures are intercalated in the text, generally one or two under each genus; and each volume is provided with a full table of contents and a very complete index, which will render the book exceedingly easy to consult. The classification adopted differs somewhat as regards the sequence of the orders from that in general use, and indeed from that of the author's 'Fishes of India,' inasmuch as it commences with the Chondropterygii, which are directly followed by the Physostomi, and these by the Acanthopterygii, the remaining orders coming in the same sequence in both works. No reason is given for this change, which, however, is not of much consequence, as the book is not intended as a guide to Ichthyological classification.

In the conclusion of the Preface to the second volume the Editor informs us that a volume on Birds may very shortly be expected, and we hope that the concluding part of his own treatise on the Indian Mammalia will not be very long in making its appearance. The completion of this and of the other volumes on Birds and on the Reptiles and Batrachia will furnish students with a most valuable help in the study of the Vertebrata of the Indian region, and we can only repeat the hope that means may be found to enable the Invertebrate fauna to be treated in a somewhat similar manner. Of course the extent of the ground to be covered will always render it impossible to treat the groups of the Invertebrata in the style adopted in these volumes, but catalogues with tabulated characters would be of inestimable value to zoologists, and surely the men might be found to do the necessary work if only the authorities can see their way to carry out such a plan.

Bergens Museums Aarsberetning for 1888. 8vo. Bergen, 1889.

The Annual Report issued by the Museum at Bergen for the year 1888, besides the usual statements as to the state of progress of the establishment, and an obituary notice of Mr. A. Lorange, the late curator of its Antiquarian department, and a description with figures of some curious vessels, chiefly drinking-cups, formerly belonging to the guilds of Bergen but now deposited in the Museum, contains several articles of considerable interest to naturalists.

The first of these is a description by Dr. Danielssen of a new species of *Cerianthus*, which he names *C. borealis*, originally obtained by him in 1858 near Molde and since found near Bergen and in the Hardangerfjord. Dr. Danielssen from the first regarded it as a distinct species, but his colleague in the production of the 'Fauna littoralis Norvegiæ,' the late Dr. J. Koren, came to the conclusion that it was identical with Gosse's *Cerianthus Lloydii*. Continued observation, however, has convinced Dr. Danielssen that the Norwegian species is quite distinct from *C. Lloydii*, and he now describes and figures it, with details, under the above name. As the two forms are very nearly allied it seems quite possible that *C. borealis* may occur upon our own coasts and have been hitherto regarded as belonging to *C. Lloydii*, so that a note of the characters attributed to the new species may be acceptable to some of our readers. Dr. Danielssen describes it as having an elongate cylindrical body, 36 millim. long, and living in a tube of about double that length and closed at the bottom. The body of the animal is a little wider in the middle, and tapers off especially towards the posterior extremity, where there is a round aperture. The upper margin, which is finely corrugated longitudinally, can be drawn over the buccal disk and tentacles so as to conceal them almost entirely. The buccal disk is somewhat depressed, and the oblong central mouth has two mouth-angles. The marginal tentacles are in two alternating rows, 18–27 in each row; they are not retractile, nor are the buccal tentacles, which are of the same number and arranged in two irregular series. The body is yellowish white, with the disk rather darker, and the tentacles have a brownish tinge.

The second article is a continuation of Mr. James A. Grieg's account of the results of his investigations of the fauna of the Westland fjords, in which he enumerates the Echinoderms, Annelides, Polyzoa, Myzostomida, and Pycnogonida obtained by him in the Mosterfjord. These notices of animal forms occurring off the shores of a country so near to us as Norway must be of considerable interest to British zoologists, and their value is enhanced by the statements with regard to mode of occurrence which are given in connexion with several of the species. In this paper Mr. Grieg also describes a new species of the Holothurian genus *Cucumaria*, under the name of *C. mosterensis*, which is figured with details in an accompanying plate.

In another article Mr. Grieg describes examples of the White-beaked Dolphin (*Lagenorhynchus albirostris*) captured in April last at Bildöen. Mr. Grieg gives a full description of the species with very carefully prepared tables of measurements of the various parts of the skulls and skeletons of individuals captured. A good figure is given of a female specimen.

Another zoological paper is that by Mr. G. Armauer Hansen on *Neomenia*, *Proneomenia*, and *Chætoderma*, in which the nomenclature and characters of those three Gephyrean genera are discussed and illustrated in a plate. Of *Neomenia* the author cites three species, namely, *N. carinata*, *affinis*, and *Dalyelli*: the last a form noticed by Dalyell under the name of "*Vermiculus crassus*;" the first originally named *Solenopus nitidulus* by Sars, but never described by him. *Proneomenia*, a genus established in 1882 by Hubrecht, includes all the other *Neomeniæ* described by Koren and Danielssen in the account of the Norwegian North-sea Expedition, besides the type species, *P. Sluiteri* of Hubrecht, and a new species, here noted by the author under the name of *P. filiformis*. This is an important discussion of the characters of some exceedingly curious and obscure forms of animals.

Of the two remaining papers one contains an account of a curious series of experiments by Dr. J. Brunchorst on "Galvanotropism," or the peculiar influence exerted by the galvanic current upon the direction of growth of the roots of plants. This curious paper, which is illustrated with a considerable number of woodcuts, leads up to the following general result:—"The negative galvanotropic curvature depends upon irritant action and is so far analogous to the geotropic and heliotropic movements; while the positive galvanotropic curvature is simply a chemico-pathological phenomenon, having only a purely external analogy with the directional movements of the roots, and therefore does not deserve the name of galvanotropism."

The remaining paper in the volume consists of a long list of earthquake shocks recorded as having occurred in Norway since the year 1758. The number is very considerable, especially of late years, when, probably, a closer observation has been kept upon such phenomena. The author of this article is Mr. T. C. Thomassen, and in his concluding remarks some interesting generalizations will be found.

Proceedings of the Bristol Naturalists' Society. New Series, vol. vi. part i. for 1888–89. Pp. 1–164. 8vo. Bristol, 1889.

The Zoologists have many interesting notes and papers in this part i. of vol. vi. n. s. Thus, the putrefactive organisms, discovered and described by the Rev. Dr. W. H. Dallinger, throughout their wonderful succession of forms, adapted more or less obviously to the dissolution and breaking up of decomposing matter, constitute a subject of great importance both in the elucidation of life and beings, and in explanation of the phenomena of putrefaction and fermentation.

In Entomology, Mr. W. K. Mann notices the rare lepidopterous *Heliothis scutosa* as having been caught in North Somerset; and Mr. G. C. Griffiths treats of Mimicry amongst the Lepidoptera. Snakes, their habits and their reputed power of fascination, are the subjects of two interesting papers by Dr. W. Duncan and Dr. A. J. Harrison. Some Birds exhibited at the meetings are mentioned, three of them rare in this country. Personal and collected observations on the Mole, by Mr. C. I. Trusted, are well worth noting. Mr. G. M. Smith gives a short account of the water-cells in the Camel's stomach. There is also a short but thoughtful note on the "perceptions of animals," by Prof. C. Lloyd Morgan; technically expressed, "the inferences of animals" are said to be "habitual and intelligent, but not rational."

Voice, language, and phonetic spelling, especially the advantages of the last, are succinctly but clearly treated by Dr. A. B. Prowse.

For Botany, Mr. J. W. White has "Notes Supplemental to the Flora of the Bristol Coal-field," and Mr. C. Bucknell gives part xi. of "The Fungi of the Bristol District." Mr. C. Jecks offers some good suggestions as to the causes of the difference in the colour between the flowers and foliage of Tropical and of Temperate regions.

Local Geologists and others may well be thankful to Prof. C. Lloyd Morgan for his elucidation of the Geology of Tytherington and Grovesend, illustrated with a geological map and section along the Yate-and-Thornbury branch railway from the Midland Railway on its way to Gloucester. The Old Red Sandstone, the Mountain Limestone, and the Keuper beds constitute the country. Their subdivisions are compared with the strata at Clifton and elsewhere, and their faultings, discordances, and overlaps are carefully described and made to account for some of the physical features of the surface. Mr. T. M. Reade's work "On Mountain-building" is carefully and favourably reviewed by the Rev. M. B. Saunders.

Meteorological observations are given by Dr. G. F. Burder and Mr. D. Rintoul.

The Engineers have three excellent and most interesting papers:—on Sewage Systems, very fully and thoughtfully, by Mr. A. P. I. Cotterell; on the loading, delivery, and warehousing of Grain in all their details, by Mr. J. M. McCurrich; and Mr. G. E. Crawford's short but most noteworthy and technical explanation of the height, foundations, materials, shape, stability, and utility of the Eiffel Tower.

Thus at least five of the several branches of Scientific Research have received attention at Bristol, and some considerable increase of facts, generalizations, and practical application, during the past year; and doubtless these published papers and abstracts will be not only useful as memoranda, but will be good and fertile seed in further cultivation of the several fields of knowledge to which they belong.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

November 6, 1889.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "Contributions to our Knowledge of the Dinosaurs of the Wealden and the Sauropterygians of the Purbeck and Oxford Clay." By R. Lydekker, Esq., B.A., F.G.S.

The first section of this paper was devoted to the description of the remains of Iguanodonts from the Wadhurst Clay near Hastings collected by Mr. C. Dawson. They were considered to indicate two species, for which the names *Iguanodon hollingtoniensis* and *I. Fittoni* had been proposed in a preliminary notice.

In the second section an imperfect metatarsus of a species of *Megalosaurus* from the Hastings Wealden was described, and shown to indicate a species quite distinct from the one to which a metatarsus from the Wealden of Cuckfield belonged. Two cervical vertebræ of a Sauropterygian from the Purbeck of the Isle of Portland were next described, and referred to *Cimoliosaurus portlandicus*, Owen, sp.

The concluding section described an imperfect skeleton of a large Pliosaur from the Oxford Clay, in the collection of Mr. A. N. Leeds, which indicated a species intermediate between the typical Kimeridgian forms and the genus *Peloneustes*. These specimens were considered as probably referable to *Pliosaurus ferox*. Evidence was adduced to show that *Pliosaurus Evansi*, Seeley, should be transferred to *Peloneustes*.

2. "On some Palæozoic Ostracoda from North America, Wales, and Ireland." By Prof. T. Rupert Jones, F.R.S., F.G.S.

The chief materials referred to were:—

1. Some good specimens of North-American Ostracoda from the Lower Helderberg and Cincinnati Groups in the British Museum and the Author's collection; these have given occasion for a critical revision and careful illustration of several forms.

2. In the 'Palæontology of New York,' vol. iii. 1859, several of the Palæozoic Ostracoda of New York State were described but not figured. Copies of some of the original drawings have been courteously supplied, with Dr. James Hall's permission, by Mr. J. M. Clarke, of Albany. They enlarge our knowledge of the Lower Helderberg fauna.

3. A large collection of Palæozoic Ostracoda, collected in the Lake Champlain district and elsewhere, sent by Prof. R. P. Whitfield, of New York, for examination by the Author.

4. Other specimens belonging to the Utica Slate Series from Ontario, presented to the Author by Dr. John Young.

5. An interesting series of Lower-Silurian (Ordovician) species from near Welshpool, comprising a characteristic Cincinnati species, sent by Mr. J. Bickerton Morgan.

6. A rare Palæozoic Cytheroid Ostracod from Kildare, collected by Mr. Joseph Wright, F.G.S.

The specimens were described as nearly as possible in the order of their natural relationship, and thus, besides adding to the known forms, they were shown to illustrate the modifications exhibited by the genera and species of these minute bivalved Crustaceans, both in limited districts and in different regions.

Amongst the forms described were the following new species and variety :—*Primitia mundula*, Jones, var. *cambrica*, nov.; *P. humilior*, sp. nov.; *P. Morgani*, sp. nov.; *P. Ulrichi*, sp. nov.; *P. Whitfieldi*, sp. nov.; *Entomis rhomboidea*, sp. nov.; *Strepula sigmoidalis*, sp. nov.; *Beyrichia Hallii*, sp. nov.; *Isochilina lineata*, sp. nov.; *I.? fabacea*, sp. nov.; *Leperditia Claypolei*, sp. nov.; *Xestoleberis Wrightii*, sp. nov.

MISCELLANEOUS.

On a new Entoniscian (Pinnotherion vermiforme, *gen. et sp. nov.*) *parasitic on the* Pinnotheres *of* Modiola. By MM. A. Giard and J. Bonnier.

The animal which is the subject of this note is doubly interesting, as belonging to a group of little-known Crustacea and as furnishing a new example of parasitism in the second degree.

Crabs of the genus *Pinnotheres* occur commonly at Wimereux in *Mytilus edulis*, Linn., *Modiola modiolus*, Linn., and *Mactra stultorum*, Linn.; more rarely in *Cardium edule*, Linn., and *Donax anatinum*, Lam. Several specific forms are no doubt confounded under the name of *Pinnotheres pisum*, Linn. In September last we found in an old *Modiola* (covered with *Serpulæ* and all perforated by *Clionæ*) a female *Pinnotheres* of considerable size (15 mill. wide), but differing from *P. veterum*, Bosc, which is said sometimes to inhabit the *Modiolæ*. This female bore no ova, and the ovigerous feet were slightly atrophied. But our attention was particularly attracted by a violet-grey mass, visible through the transparent dorsal integument, and resembling in aspect an egg-mass of *Grapsion Carolinii*, Giard. A puncture made with a slender-pointed pipette furnished mature embryos of an Entoniscian, and taking all the precautions indispensable in such cases, we were soon able to extract the adult female which contained these embryos in her incubatory cavity. The latter occupied the whole left side of the visceral cavity of the *Pinnotheres*, from the frontal margin of the carapace, and, contrary to what occurs in other Entoniscians, it was prolonged into the caudal portion of the Crab as far as the third segment of the abdomen. The genital glands of the host were atrophied, the liver much reduced and very pale. The sac enveloping the parasite adhered to the right branchial part and passed, as customary, beneath the intestine.

This parasite, which we shall call *Pinnotherion vermiforme*, belongs to a new genus. The characters, in the female sex, are furnished especially by the form of the first incubatory plate and by the ovarian bosses. The first incubatory plate is destitute of a transverse lamella, and its recurrent portion is of unusual length. There are no dorsal ovarian bosses. The ventral bosses are two in number; the second (posterior), which is excessively long and cylindrical, seems to form the prolongation of the body of the animal, of which it displaces towards the back the pleon bent into a V with the cephalic part. The muscles of the wall of the body which covers the ovary, notwithstanding this enormous distention, have retained great power, and the ovarian bosses contract energetically. The second, especially, exhibits vermiform movements, which enable it to bend back and to insinuate itself, as has been said, into the tail of the Crab, notwithstanding the folding forward of the latter. The organs situated in the neighbourhood of the genital aperture, and called *seminal receptacles*, are of a nearly ovoid form, and their surface presents four or five lobes arranged like the ribs of a melon. The liver, of a fine cherry-red colour, was filled with an abundant liquid, holding in suspension concretions analogous to renal products. This, however, is the ordinary aspect of the liver of the Entoniscians some time after oviposition, between two periods of sexual activity. This supposed liver seems to play the double part of an organ of excretion and an organ of reserve. The pleon and its lateral and terminal appendages greatly resemble the corresponding parts in *Grapsion*.

In the midst of the embryos, and attached to the folds of the incubatory laminæ, there were two degraded males; notwithstanding careful search with the lens and the microscope, we did not meet with any Cryptoniscian males. One of the two degraded males measured 2 mill. and was in full sexual maturity; it was destined, no doubt, to fecundate the next deposit of ova. The other was much smaller (one third), dead and already partially decomposed; it must have fecundated the ova then developed. The degraded male resembles those of *Grapsion* and *Portunion*, but it is almost entirely destitute of pigment. The caudal furca is very long; further, the median ventral hooks are placed upon the seventh thoracic segment (genital segment) and on the first pleal segment; the second pleal segment only bears a small rudimentary tubercle. The males of all the Entoniscians at present known bear no median hook upon the genital segment. The appendage of *Priapion* is of quite a different nature. In *Pinnotherion* the apertures of the deferent ducts are situated, not upon the median appendage, but towards the anterior margin of the seventh segment.

The spermatozoids, fixed by osmic acid and examined, after coloration, with homogeneous immersion, present the complex structure of the spermatozoids of the Thoracostraca, but they have not the streaks characteristic of those of the Lobster, Cray-fish, &c.

The embryo greatly resembles that of *Grapsion* and *Portunion*. It is strongly pigmented with brown and green, notwithstanding the obscurity of the medium in which it is developed. Its eyes are large. The albumino-fatty lobules present a regular metameric arrangement, as in the embryo of *Athalges paguri*, Rathke. The liver is very strongly contractile. The claw of the sixth pereiopod is long and powerful; the terminal rod short and very transparent.

To sum up, in the principal features of its organization the genus *Pinnotherion* seems to be especially allied to *Grapsion*; but it is clearly distinguished in the female sex by the form of the first incubatory plate and of the ovary; in the male sex by the arrangement of the median ventral hooks.

Pinnotherion vermiforme seems to be very rare, since we have only met with a single couple, although we have examined hundreds of *Pinnotheres* obtained from the various Acephalous Mollusca enumerated above.—*Comptes Rendus*, December 9, 1889, p. 914.

Deep-sea Trawling off the S.W. Coast of Ireland.—Additional Foraminifera. By Joseph Wright.

With reference to the "Report of a Deep-sea Trawling Cruise off the S.W. Coast of Ireland," Foraminifera, by Joseph Wright, published in the 'Annals' for December 1889, the following corrections are necessary:—*Rheophax distans*, Brady, should be *Hormosina Carpenteri*, Brady, as shown by further examinations; *Textularia agglutinans*, d'Orb., and *T. aspera*, Brady, should be omitted for the present as not altogether satisfactory. The following are some additional species which have since been found:—

Rheophax membranacea, Brady. Very rare.
Haplophragmium glomeratum, Brady. Common.
Textularia concava, Karrer. Not typical. Very rare.
Bolivina lobata (Brady). Very small. Very rare.
Cassidulina crassa, d'Orb. Very rare.
Lagena Orbignyana (Seg.). Very rare.
—— *marginata* (W. & B.). Trigonal form. Very rare.
—— *fimbriata*, Brady. Very rare.
Nodosaria inflexa, Rss. Very rare.
Globigerina sacculifera, Brady. Very small. Very rare.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

No. 26. FEBRUARY 1890.

XVI.—*On the Structure of* Coccosteus decipiens, *Agassiz.* By R. H. Traquair, M.D., F.R.S.*

[Plate X.]

In a paper on *Homosteus* (13) published in the 'Geological Magazine' for January 1889 I entered into the structure of *Coccosteus* so far as was necessary for the purpose of instituting a comparison between the two genera. In the present communication I propose to consider the structure of *Coccosteus* in greater detail.

The figure which I gave in that paper of the cranial shield is reproduced in Pl. X. fig. 2, with the addition of the dorsal cuirass. It is, I believe, accurate, and represents the result of a close study of a very great number of heads. Comparatively few specimens are, however, available for the purpose, those especially from Lethen and most of those from Orkney being ill-adapted for following the sutures separating the plates, while Cromarty and Edderton furnish those in which the surface is most perfectly preserved, thus affording the best opportunity for accurately distinguishing the true sutures from those superficial grooves which in past times have been so often confounded with them. Quite recently, however, the

* Read before the Royal Physical Society of Edinburgh, 18th December, 1889.

Edinburgh Museum has acquired a small collection of *Coccosteus*-remains from Stromness, in Orkney, in which the details of the surface of the cranial plates are most beautifully shown, and are entirely corroborative of the sketch which I published a year ago.

As I have previously stated (12, p. 511), I retain only two species of *Coccosteus* from the Scottish Lower Old Red Sandstone, namely *C. decipiens*, Ag., and *C. minor*, H. Miller, the differences which have led to the separation of "*oblongus*," Ag., "*cuspidatus*," Ag., *microspondylus*, *trigonaspis*, and *pusillus*, M'Coy, and *Milleri*, Egert., being dependent either upon the mode of preservation or upon trivial variations in the shape of certain plates, which are extremely common up to certain limits. That which I find especially difficult to understand is how Prof. von Koenen (10) should propose to remove *C. Milleri*, Egert., and *C. pusillus*, M'Coy, from *Coccosteus* altogether, placing them in *Brachydeirus*, the fact being that they are simply synonyms of *decipiens*, Ag. *C. minor*, H. Miller, once mixed up with *C. pusillus*, M'Coy, may possibly have to be put into a new genus on account of the structure of the vertebral column, which presents an appearance as if possessed of ossified centra *; but I can see no reason for associating this species with v. Koenen's *Brachydeirus*.

The following description of the structure of the bony skeleton of *Coccosteus* is therefore based upon an examination of the common and well-known species *C. decipiens*, Agassiz.

Head.—In Pl. X. fig. 2 the bones forming the cranial shield are sketched, as well as the ramifications of the lateral-line grooves. These bones are:—one median occipital (*m. o.*), two external occipitals (*e. o.*), two central plates (*c.*), two *marginals* (*m.*), two *postorbitals* (*pt.o.*), two *preorbitals* (*p.o.*), one *posterior ethmoidal* (*p. e.*), and one *anterior ethmoidal* (*a. e.*), between which last and the premaxillæ (*p.mx.*) the nasal openings (*n.*) are observable. I have already (13, p. 5) explained that I have applied those names without the intention of considering any of the bones exact equivalents of bones similarly named in ordinary fishes.

The orbit, the upper margin of which is formed by the excavated outer edges of the post- and preorbital buckler-plates, is completed below by the *superior maxillary* bone (*m.x.* fig. 1), which strongly resembles in shape that of typical Palæoniscidæ in being broadly expanded behind, where it covers the cheek, and suddenly excavated to form a tapering process

* This is apparently the species "with a true bony vertebra" referred to by Murchison in 'Siluria,' 3rd ed. p. 504.

directed forwards under the eye to the premaxilla. To the posterior margin of the maxilla is fixed the *jugal* or post-maxilla, a triangular plate with posteriorly directed apex, which fills up the space between the maxilla and the lateral part of the body-cuirass.

So far as I can see, the maxilla of *Coccosteus decipiens* does not seem to have borne any teeth. But in a specimen from Gamrie in the Edinburgh Museum there is distinct evidence of the presence of both vomerine and palatal teeth. The specimen lies on its back, giving a beautiful view of the ventral cuirass, in front of which are the two rami of the mandible converging to meet each other anteriorly, while external to and in front of them the upper margin of the oral cleft is seen formed by the maxillæ and premaxillæ. No teeth are, as usual, seen on the maxillæ, but internal to them and between them and the contiguous mandibular ramus is seen a row of conical teeth, evidently placed on the edge of a palatal or palato-pterygoid bone, which I have not yet seen in its entirety. Also in front of the meeting of the mandibular rami and behind the premaxillary and ethmoidal region is a clump of five conical teeth, clearly vomerine in position at all events. It is also clear that the whole of the dentition of the front of the mouth is not here exposed, as the clump referred to is on the left side of the middle line, and the corresponding space on the right side is covered by the anterior extremity of the corresponding mandible.

The bone representing the mandible is well known from the description of Hugh Miller. It is an elongated, vertically-flattened plate (fig. 1, *mn.*), broader behind than in front, with rounded posterior extremity, slightly sigmoid contour when seen from the side, and near the anterior extremity sharply bent inwards towards its fellow. It is remarkable for having two sets of conical teeth, one consisting of a row of about half a dozen being situated about the middle of the upper margin of the bone, while another row of about the same number occupies the vertical anterior margin, which would otherwise be *symphysial.* This is certainly a very curious circumstance, and one is simply at a loss to imagine of what use teeth could be in such a situation, or how they worked. It was indeed the position of these peculiar symphysial teeth that led Hugh Miller originally to compare the working of the jaws of *Coccosteus* with those of an Arthropod (2, 1st ed. p. 57; see also footnote in 4th and subsequent editions).

There are no traces of ossified internal cranial bones, of hyoid or of branchial arches; consequently these parts must have been entirely cartilaginous. I may mention that the bones figured by Huxley as "the chief parts of the hyoidean arch" are in reality the ventral rami of the dermal plates which I have termed "interlateral."

Body-Cuirass.—The front part of the body behind the head is encircled by a girdle of osseous dermal plates, somewhat comparable to a shoulder-girdle, expanded backwards dorsally and ventrally, while at the lower part of the sides the cuirass is so deeply cut in that the dorsal and ventral expansions were long considered to have no connexion with each other. Most of the osseous plates which form this cuirass are well known from the writings of Pander, H. Miller, and Sir P. Egerton, but nevertheless some correction is still necessary.

The great *median dorsal* plate (fig. 2, *m. d.*) is of an elongated pentagonal figure, its short base articulating with the median and lateral occipitals, its acute apex and elongated sides articulating with the two dorso-lateral plates, which it extensively overlaps. Its under surface shows the well-known median longitudinal ridge, ending behind in the "nail-head" prominence, as in the corresponding plate in *Homosteus.* The *anterior dorso-lateral plate*, the *os articulare dorsi* of Pander, (*a. d. l.*), is of a somewhat rectangular form when detached, though *in situ* it appears irregularly trapezoidal owing to its upper and lower margins being obliquely overlapped by the median dorsal and by the antero-lateral respectively; its anterior margin shows a small articular process by which it is joined to the external occipital. Immediately behind it is placed the *posterior dorso-lateral* (*p. d. l.*), or the *os triangulare* of Pander, a triangular plate which also articulates with the median dorsal above and the postero-lateral below, while its oblique hinder border is free.

The antero-lateral plate (*a. l.*), being the *os marginale* of Pander, occupies a position below and in front at the narrowest part of the lateral portion of the cuirass. It is peculiarly trapezoidal in shape, or it might be described as triangular, with the downward and forwardly directed apex obliquely truncated. Its anterior border, gently convex in the middle, forms part of the anterior margin of the cuirass, though it is for the most part shut out from that by the anterior dorso-lateral above and the interlateral below; its postero-superior margin, somewhat wavy or zigzagged, overlaps the anterior dorso-lateral besides articulating with the small postero-lateral. The postero-inferior margin is free and slopes obliquely downwards and forwards; the short anterior margin is fitted on to the interlateral. This antero-lateral plate is the one lettered "*c*" by Huxley (8, p. 30) and "3" by Hugh Miller (7, p. 133, fig. 6), though he has represented the very same plate on the preceding page (p. 132, fig. 5, *z z*) as forming a part of the ventral cuirass.

The postero-lateral plate (*p. l.*) is a small one situated at the posterior angulated margin of the lateral part of the cuirass and articulates with the antero-lateral, the anterior dorso-lateral, and the posterior dorso-lateral, its posterior margin being free. This plate is not noticed by Pander or Huxley, but it is lettered 2 by Hugh Miller (7, p. 133, fig. 6).

The *interlateral plate* (*i. l.*) is one of great interest, as its form and relations have not yet been properly recognized. It consists of two parts, lateral and ventral, united at a considerable angle to each other when uncompressed, which, however, is very rarely the case. The lateral portion, seen in fig. 1, forms a sort of fork, on which the short inferior margin of the antero-lateral plate articulates, and thus is formed that connexion between the dorso-lateral and ventral portions of the cuirass which was unknown to Pander and Huxley, and which, so far as I am aware, has not previously been demonstrated. The lower limb of the fork forms a conspicuous rounded lower margin, tuberculated like the other plates, and bears a most suspicious resemblance to the part represented by Prof. v. Koenen as a pectoral spine in *C. Bickensis* (10, pl. ii. fig. 2). In *C. decipiens* it is, however, very much shorter than the part alluded to in *C. Bickensis*; however, in *C. minor* it attains a very considerable proportional length (13, pl. i. fig. 3, *i. l.*). The ventral portion (see fig. 3), devoid of tubercular ornament, is elongated in shape, and, passing inwards and slightly forwards to meet its fellow of the opposite side, forms the anterior margin of the ventral portion of the body-cuirass; to it posteriorly are articulated the anterior ventro-lateral and the anterior median plates. This part of the bone was known to Pander, and is represented in two of his figures (6, pl. ii. fig. 2, and pl. v. fig. 1, *x*), though in the text he compared it with the jugular plate in *Polypterus* or *Osteolepis*. Huxley, on the other hand (8, p. 35, fig. 21, *a*), considered the bone to be hyoidean in its nature, as we have already noticed.

Neither Pander nor Huxley seems to have recognized the lateral portion of this bone, which serves to articulate the dorso-lateral portion of the cuirass with the ventral; indeed, Huxley remarks (8, p. 32) that "the ventral shield appears to me to have had no connexion with the dorsal." But of the connexion of the two in the manner I have described there cannot be the slightest doubt. See also my figure of the parts in *C. minor* (13, pl. i. fig. 3).

The plates forming the expanse of the ventral shield are already so well known from the figures of Pander and Hugh Miller that I need hardly enter into detail regarding them, especially as I have in Pl. X. fig. 3 accurately given their respective shape and mode of overlap. They are six in number :—*anterior median ventral* (*a. m. v.*), *posterior median ventral* (*p. m. v.*), two *anterior ventro-laterals* (*a. v. l.*), and two *posterior ventro-laterals* (*p. v. l.*). I may, however, mention that, judging from the course of the lateral-line groove on the anterior ventro-lateral plate, Pander has reversed its position, putting the front end behind and *vice versâ*; for we shall presently see that on this plate the sensory canal occurs on the anterior and not on the posterior part of its surface.

Distribution of the Lateral-line Grooves.—The course of the lateral sensory canal is indicated on certain of the dermal bones by conspicuous grooves, which, as in the case of *Pterichthys* and *Bothriolepis*, have often been mistaken for sutures. There is, however, no difficulty in distinguishing them from sutures, when one by experience really comes to know the characteristic appearance of the latter.

On the anterior half of each anterior ventro-lateral plate is seen a curved groove, starting from near the middle of the anterior margin and then curving sharply round to proceed to the inner border close behind the antero-internal angle. On the median dorsal plate a groove is seen of a V-shaped contour, the apex being in the middle line somewhat in front of the posterior extremity of the bone, the limbs diverging forwards towards the superior margin of the posterior dorso-lateral plate. On the anterior dorso-lateral plate a continuation of this groove runs forwards to the postero-internal angle of the external occipital, near which it is met by a branch coming diagonally upwards and forwards from the postero-inferior angle of the plate. The side-canal thus formed passes now on to the cranial shield at the point indicated, and there at once gives off a branch running forwards and slightly inwards, parallel with and close to the outer margin of the median occipital, becoming lost on the posterior margin of the central. The main groove then runs forwards and outwards parallel with the outer margin of the shield, giving off first a branch passing to the external projecting angle of the marginal plate, then turning forwards and inwards still parallel to the shield-margin it passes on to the postorbital plate, where it gives off another branch to the postorbital angle. Here it bends sharply backwards and inwards at an acute angle, runs on to the central plate, approaching its fellow of the opposite side, and near the middle of this plate it again turns sharply forwards, passes on to the anterior part of the preorbital and ends near the small nasal opening in front. In some specimens a cross commissural branch is seen on the central plates, connecting the two main trunks at the conspicuous angles which they make in that place.

A groove is also observable on the maxilla, apparently continued from the second external branch of the main groove on the postorbital, and passing along as a suborbital branch close to the hollowed-out orbital margin of the bone. It gives off behind the eye another branch, which passes in a curved manner downwards and backwards towards the margin of the bone posteriorly.

Sclerotic Ring.—A specimen from Gamrie in the Edinburgh Museum shows evidence of a sclerotic ring such as has been figured by v. Koenen (10, pl. ii. fig. 2, pl. iv. fig. 2).

Internal Skeleton.—In the typical *Coccosteus decipiens*, Ag., there is no trace of vertebral centra, the space occupied by the persistent notochord being always empty in the fossils. Agassiz in his restored figure (1, pl. vi. fig. 3) has represented on both dorsal and ventral aspects of the notochordal space a continuous row of distally-pointed neurapophyses and hæmapophyses, also a dorsal and anal fin situated opposite each other, each supported in Teleostean fashion by a series of proximally-pointed interspinous bones, dipping down between the neurapophyses, the supposed fin-rays being, according to the same idea, pointed at their extremities. Pander (6, pl. iv. fig. 1) still retains the two median fins, with the long hæmapophyses in front of the anal, though he was more correct in making the interspinous bones articulate end to end with the neurapophyses by expanded extremities. But though M'Coy had previously (5, p. 602) strongly doubted the existence of an anal fin in *Coccosteus*, Pander's figure has been copied into almost every text-book; Prof. von Koenen has transferred the body-skeleton and fins as there represented to his restoration of the allied genus *Brachydeirus*, while the anal fin is also mentioned as present by Zittel in his handbook (14, p. 160). M'Coy was, however, correct—there is no anal fin in *Coccosteus*; but besides this Pander's figure is incorrect in other points, which I shall now indicate.

It is not possible to trace the vertebral column to its commencement, owing to its obscuration by the dorso-lateral cuirass; where it first becomes visible is about the middle of the length of the great median dorsal plate. There we find short broad neural pieces continued obliquely backwards and upwards into neural spines, which gradually lengthen until we come to the dorsal fin, which commences a little beyond the apex of the plate just mentioned. Here we have two sets of interspinous bones articulated end to end with each other and with the neural spines, which latter are truncated and not pointed. In a very good specimen in the British Museum I count about fifteen ossicles in the proximal set and twelve in the distal, though probably the numbers were equal in the perfect state, and in both sets they have the same form, namely they are slender, elongated, and expanded at both extremities. It is evident from the last-mentioned circumstance that the ossicles of the second row are not dermal fin-rays, but belong to the same category as those of the first; two rows of interspinous bones being, in fact, of constant occurrence in the primitive Ganoids.

Beyond the dorsal fin the neural spines become very short as well as less oblique in their direction.

On the hæmal aspect of the vertebral axis no such elongated apophyses occur anteriorly, as depicted in the restorations of Agassiz and Pander. Immediately behind the lateral plates of the cuirass we find small, nearly circular, hæmal pieces *without spines*, then spines are added which, gradually lengthening, become longest in the region opposite the dorsal fin, whence they again diminish towards the extremity of the tail. It is this peculiar lengthening of the hæmapophyses under the dorsal, a fact also noticed by M'Coy, which has evidently given rise to the old idea of the presence of an anal fin.

In all specimens of *Coccosteus* where the internal skeleton is well preserved there is found a pair of peculiar slender bones (x), each of which is pointed at both ends and bent below the middle at an obtuse angle in somewhat L-shaped fashion, the long limb pointing upwards towards the vertebral axis, the short one forwards. These bones were noticed by Pander (6, p. 73), who, though extremely doubtful as to their nature, supposed that they "vielleicht den Extremitäten als Stützen der weichen Flossen angehörten." Their position is certainly suggestive of their having had something to do with pelvic limbs—more I cannot say.

Mr. A. Smith Woodward has pointed out to me that in several specimens in the British Museum a small oval or somewhat rhombic bony plate (y) is seen lying in a position posterior to the last-mentioned bones. I have not observed it in any other specimens than those; but its presence in a similar position in more than one example would seem to indicate that it was a scute placed in the ventral mesial line.

Were pectoral members present?—I have now examined with the utmost care a very great number of specimens of

Coccosteus decipiens in all conditions of preservation and from all the beds and localities of the Scottish Old Red Sandstone which have yielded such remains, including the collections in the British Museum, in the Museum of Practical Geology, in the Edinburgh Museum of Science and Art, the Gordon-Cumming collection at Forres, and many others, but without meeting with any other parts either of endo- or exoskeleton than those I have described. And, in particular, I have not seen the smallest evidence of the presence of any pectoral limb, nor any trace of an articular surface on any of the bones to which such a limb could have been articulated. It can scarcely be believed that had such a limb been present it would either have escaped preservation or observation in so large a number of specimens. Nevertheless more than one author has been disposed to believe in the presence of such a limb in *Coccosteus.*

In the restored figure of *Coccosteus* given by Hugh Miller in the first edition of the 'Old Red Sandstone' (2, pl. iii.) no limb is represented, and its absence is positively affirmed in the text. But in subsequent editions, and also in Duff's 'Geology of Moray' (3, pl. viii. fig. 1), a peculiar "paddle-shaped" body is represented appended to the head. However, Hugh Miller, in a footnote, explains that he has ascertained that the supposed arms "were simply plates of a peculiar form." Of course there is not the smallest doubt that the idea of this limb owed its origin to a displaced maxillary bone.

But more recently, in connexion with what appear undoubtedly to be fragments of a large and peculiar form of *Coccosteus*, Trautschold (9 and 11) has described and figured from the Old Red Sandstone of Russia certain peculiar bodies, which he considers, though not without doubt, to appertain to supposed large arms or "Ruderorgane" belonging to that species, which he accordingly names *Coccosteus megalopteryx.* What the fragments are to which he applies the term "Oberarm" I have not the slightest idea, as I have not seen them, and certainly nothing like them has ever been found along with *Coccosteus decipiens.* But with regard to the peculiar flat triangular bodies represented in his first memoir on the subject (9, tab. vi. and tab. vii. fig. 2), I have had the privilege of examining two specimens contained in the British Museum.

In the first place there is no evidence whatever that these bodies belong to *Coccosteus* at all, any more than the supposed "Oberarm," as nothing in any way resembling them has ever been seen in connexion with the most perfect specimens of *C. decipiens*, the type of the genus, which the Scottish Old Red

Sandstone has afforded. Prof. v. Koenen has also expressed grave doubts (10, supplementary note) as to their having belonged to *Coccosteus*, though he thinks it not impossible that the piece referred to as "Oberarm" may be identical with the "stabförmiges Ruderorgan," the existence of which he himself maintains.

In the second place it seems to me highly probable that they are Selachian appendages; indeed, their form and appearance is strongly suggestive of an affinity with *Oracanthus*, which is certainly Selachian, although some years ago Mr. J. W. Davis was inclined to refer it to the Placodermi, though *not* as a pectoral limb. These so-called "Flossen" are flat bodies, of a horn-shaped outline, pointed, with one margin convex, the other concave, truncate base, and rounded lateral edges. A great part of the surface is sculptured with closely-set tubercles, which are occasionally irregularly elongated, and all with stellate bases; these tubercles being an integral part of the substance of the appendage, the term "Schuppenhaut" applied to them by Prof. Trautschold seems hardly appropriate. The basal margin of the body is not tuberculated but striated, and this striated portion extends further up on one side than on the other.

Now, Prof. Trautschold admits (11, p. 36, note) that the body figured by Pander as an "*ichthyodorulithe*" (6, pl. vii. fig. 22) is identical with the end of one of the supposed "fins" of *Coccosteus megalopteryx*; and if so, then its microscopic structure is not that of a Coccostean bone, but of a Selachian appendage. For here are the words in which Pander refers to the body in question:—"Fig. 22. Ein *Ichthyodorulithe*, mit ausgezeichnet schönen Sternen auf beiden Flächen und Kanten. Die Sternchen sind äusserlich von denen von *Asterolepis*, *Coccosteus* und *Homosteus* unmöglich zu unterscheiden, aber die microscopische Structur ist ganz verschieden. Knochenhöhlen fehlen gänzlich. Die Tuberkel bestehen aus wahrer Dentine und die ganz innere Masse aus einem Gewebe von Markcanälen, umgeben von concentrischen Kreisen, in der Grundsubstanz, welche von den nach allen Seiten ausstrahlenden feinen Zahnröhrchen unter rechten Winkeln durchschnitten werden" (6, pp. 102, 103). From this description, along with Pander's figure of the microscopic structure (*ib.* fig. 34), the true nature of these bodies is, I think, pretty evident.

I am therefore quite unable to accept Prof. Trautschold's views as to the "fins" of *Coccosteus*.

But, as already mentioned, Prof. von Koenen has affirmed the presence in *Coccosteus* of a "Ruderorgan," and in his restored figure of his "subgenus" *Brachydeirus* (10, pl. iv. fig. 1) he has represented the same as a long, pointed spine diverging backwards from the antero-inferior angle of the antero-lateral plate of the cuirass. In tab. ii. fig. 2 of the same work he has also represented the spine *in situ* in a specimen of *Coccosteus Bickensis*, v. Koen.; but the supposed spine is here much shorter than in the restoration, and lies horizontally just below the antero-lateral plate, in the very spot where the outer margin of the interlateral plate occurs in Scotch specimens of the genus. I have already stated that the appearance here is strongly suggestive to my mind that this "Ruderorgan" or pectoral spine is nothing but the outer *Kante*, as the Germans would call it, of the interlateral plate. But though the corresponding part in *C. decipiens* is very much shorter than that here represented, it attains a very considerable proportional length as well as a *very spine-like appearance* in *C. minor*, H. Miller, as is shown in my outline figure of that species (13, pl. i. fig. 3). That it should also attain similar proportions in other species is highly probable.

Of course I have not seen Prof. v. Koenen's specimens, and it is not always safe to judge from figures and descriptions alone. This much I am, however, entitled to say—that if such a pectoral swimming-organ really does occur in Prof. v. Koenen's species *Bickensis*, that species cannot be referred to *Coccosteus*, in which no such organ is present. And, again, if it is present in *Brachydeirus bidorsatus*, v. Koen., then *Brachydeirus* is not merely a "subgenus" of *Coccosteus*, but a genus with a very great distinction indeed.

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(9) Trautschold, H.—" Ueber *Dendrodus* und *Coccosteus*," Trans. Imp. Russ. Min. Soc. xv., 1880.

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(13) Traquair, R. H.—" *Homosteus*, Asmuss, compared with *Coccosteus*, Agassiz," Geol. Mag. (3) vol. vi. 1889, pp. 1–8.

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EXPLANATION OF PLATE X.

(In all the figures the same letters refer to the same things.)

m. o. Median occipital.
e. o. External occipital.
m. Marginal.
c. Central.
pt.o. Postorbital.
p.o. Preorbital.
pt. e. Posterior ethmoidal.
a. e. Anterior ethmoidal.
p.mx. Premaxillary.
n. Nasal opening.
mx. Maxillary.
j. Jugal.
o. Orbit.
m. d. Median dorsal.
a. d. l. Anterior dorso-lateral.
p. d. l. Posterior dorso-lateral.
a. l. Antero-lateral.
p. l. Postero-lateral.
i. l. Interlateral.
a. m. v. Anterior median ventral.
m. v. Median ventral.
a. v. l. Anterior ventro-lateral.
p. v. l. Posterior ventro-lateral.
x. Peculiar internal bones.
y. Posterior ventral plate.
mn. Mandible.

Fig. 1. Restored outline of the skeleton of *Coccosteus decipiens*, Agassiz. The dotted lines indicate the ramifications of the lateral-line system; the thin lines on the body-cuirass here and in fig. 3 denote the overlapped edges of the plates.

Fig. 2. View of the head and dorso-lateral portion of the body-cuirass from above.

Fig. 3. View of the ventral portion of the body-cuirass from below. The thin lines denote the overlapped edges of the plates.

XVII.—*A List of the Reptiles and Batrachians of Amoorland.* By G. A. Boulenger.

[Plate IX.]

The recent acquisition by the Trustees of the British Museum, among other examples from the late Dr. J. G. Fischer's collection, of a series of Reptiles and Batrachians obtained by Hr. Dörries of Hamburg on the Ussuri River *, has induced me to publish, in addition to notes on the little-known forms, a complete list of the Reptiles and Batrachians hitherto recorded from Amoorland. This fauna presents an interesting mingling of North Palæarctic (*Lacerta vivipara*, *Vipera berus*, *Rana temporaria*), Central Asian (*Eremias*), Japanese (*Tropidonotus vibakari*), and Oriental (*Tachydromus*, *Coluber tæniurus*) types.

REPTILIA.

Lacertilia.

1. *Tachydromus amurensis.*

Peters, Sitzungsb. Ges. Naturf. Freunde, 1881, p. 71; Bouleng. Cat. Liz. iii. p. 6.

Described by Peters from examples obtained at Kasakewicha, on the Amoor. The following description is taken from four specimens (2 ♂, 2 ♀) collected at Chabarowka by Hr. Dörries.

Snout short, obtuse, its length equal to the distance between the orbit and the posterior border of the tympanum. Granules between the supraoculars and the supraciliaries absent or reduced to two or three; a small shield, sometimes broken up into two or three, separates the large anterior supraocular from the loreal; temporal scales perfectly smooth, 7 or 8 on a line between the orbit and the tympanum; four (rarely five) upper labials anterior to the subocular; three specimens have four pairs of chin-shields, the fourth has five. Large dorsal scales in 7 or 8 longitudinal series, of which the median are smaller than the others; 24 to 27 in a longitudinal series between the axils. Ventral shields smooth, outer very feebly keeled, in 8 or 10 longitudinal and 25 to 28 transverse series. Præanal shield entire in the males, divided or semidivided in the females. Three inguinal pores on each side. Brown or olive above, uniform or with darker

* I had previously described a new genus of Newts, *Geomolge Fischeri*, from the same collection (P. Z. S. 1886, p. 416).

spots, usually blackish on the granular lateral region; with or without a light streak from the eye to the collar; lower parts yellowish or greenish white.

	♂. millim.	♀. millim.
Total length	173	151
Head	12	13
Width of head	8	9
Body	44	53
Fore limb	19	20
Hind limb	25	27
Tail	117	85

2. *Lacerta vivipara*, Jacq.

Bedriaga, Abh. Senck. Ges. xiv. 1886, p. 338.

Our common lizard extends right across Europe and Asia, from the Atlantic to the Pacific, north of lat. 43° N. *Vipera berus* and *Rana temporaria* have an almost identical range. Siberian specimens in the British Museum, for which we are indebted to the kindness of Dr. Strauch, are from Padun (River Angara), Stanowoi Mountains (E. Siberia), Nicolawsk (Amoor), and Saghalien Island.

3. *Eremias argus.*

Peters, Mon. Berl. Ac. 1869, p. 61, pl. —. fig. 3.

A specimen of this common North-Chinese lizard, collected by Mr. A. Adams in Manchuria (no precise locality appended), is in the British Museum.

Ophidia.

4. *Ablabes rufodorsatus*, Cantor.

Coluber rufodorsatus, Strauch, Schl. Russ. R. p. 79.

Common over the greater part of China, and occurs in Eastern Siberia from Lake Baikal to the Amoor and Posiette Bay. The most northern locality from which we have a specimen in the British Museum is Peking.

5. *Coluber dione*, Pall.

Elaphis dione, Strauch, *op. cit.* p. 82.

Extends from South-eastern Europe through Central Asia to the Amoor (Barnard, Reinowke), Corea, Peking, and Yesso. The north-eastern specimens in the British Museum are from Peking and the Ussuri River.

6. *Coluber Schrenckii*, Strauch.

Elaphis Schrenckii, Strauch, *op. cit.* p. 100.

This species was described from specimens from the Chingan Mountains (Amoor), Posiette Bay and Wladivostok, and Hakodate in Japan. A specimen from the Ussuri River, received from the Warsaw Museum, is in the British Museum.

7. *Coluber tæniurus*, Cope.

Elaphis tæniurus, Strauch, *op. cit.*

Its range extends from Novgorodski (*Strauch*) to the Eastern Himalaya, Indo-China, Borneo, and Sumatra. The most northern specimens preserved in the National Collection are from hills north-west of Peking.

8. *Tropidonotus tigrinus*, Boie.

Strauch, *op. cit.* p. 176.

Common in North China and Japan. Recorded by Strauch from Strelok Bay (Peter the Great Bay). A specimen from Gensan, Corea, is in the British Museum.

9. *Tropidonotus vibakari*, Boie.

Strauch, *op. cit.* p. 174.

This common Japanese snake was first recorded from continental Asia by Strauch, whose specimens are from Posiette Bay and Baranowsky on the River Suifin. Two specimens from Chabarowka are in Hr. Dörries's collection, and present the following characters:—

One or two præ- and three postoculars; temporals 1+1+1, or 1+1+2, or 1+2+2; seven upper labials, third and fourth entering the eye; in one specimen the sixth labial on one side is excluded from the labial margin and becomes a temporal. Scales in 19 rows, with distinct apical pits. Ventrals 150, 151; anal divided; subcaudals 59, 60. Uniform grey-brown above, head marbled with black; lips yellowish, with black bars down the suture of the shields; a yellowish black-edged spot on each side of the occiput; lower parts yellowish white, with a series of small brown spots on each side.

10. *Vipera berus*, L.

Strauch, *op. cit.* p. 206.

Extends, like *Lacerta vivipara*, from Europe to Manchuria, as far south as Posiette Bay and Saghalien Island.

11. *Ancistrodon intermedius*, Strauch.

Trigonocephalus intermedius, Strauch, *op. cit.* p. 245.

Inhabits Eastern Siberia, as far west as the Government of Irkutsk, and Japan. Four specimens are in the British Museum, viz. one (*a*) from the River Kunge (from the St. Petersburg Museum), one (*b*) from Sincinogorsk (from the Bremen Geographical Society), and two (*c*, *d*) from Chabarowka (Dörries Collection).

The scaling of these four specimens is as follows :—

	a.	*b.*	*c.*	*d.*
Labials	7—7	7—8	7—7	7—8
Rows of scales .,..	23	23	23	23
Ventrals	161	166	155	156
Subcaudals	49	45	40	40

12. *Ancistrodon Blomhoffii*, Boie.

Trigonocephalus Blomhoffii, Strauch, *op. cit.* p. 251.

Inhabits Japan, the greater part of China, and Amoorland. In the British Museum from the Ussuri River.

BATRACHIA.

Ecaudata.

13. *Rana temporaria*, L.

The range of the common frog extends eastwards to Amoorland (Kasakewicha, *Berlin Museum*), and Yesso. The Asiatic specimens in the British Museum are from Ilisk, Eastern Turkestan (*Lansdell*), Sinus Abrek, E. Siberia, and Yesso.

14. *Rana amurensis*. (Pl. IX. fig. 1.)

Bouleng. Bull. Soc. Zool. France, 1886, p. 598.

The original description of this very distinct species, the smallest of the *temporaria*-group, was taken from two specimens from Kasakewicha, on the Amoor, preserved in the Berlin Museum. The following description is based upon nine specimens from Lake Kanka, collected by Hr. Dörries. We have also numerous specimens from Chemulpo, Corea, but in bad condition.

Vomerine teeth in two short oblique series or oval groups behind the level of the choanæ. Head rather depressed, as long as broad ; snout rather elongate, rounded, scarcely projecting ; loreal region not very oblique ; nostril halfway between the eye and the end of the snout; interorbital space a little narrower than the upper eyelid; diameter of the tympanum about two thirds the diameter of the eye; the distance between the eye and the tympanum equals half or two thirds the diameter of the latter. First finger not or scarcely extending beyond second. Tibio-tarsal articulation reaching the eye; tibia shorter than the fore limb. Inner metatarsal tubercle small, oval, blunt; no outer tubercle. Subarticular tubercles small. Toes two-thirds or three-fourths webbed. Skin smooth; dorso-lateral glandular fold feebly marked. Brown above, dorso-lateral folds edged with darker; frequently a pair of more or less distinct dark lines along the middle of the back; loreal and temporal regions blackish; a whitish streak bordering the upper lip; lower parts spotted or marbled with brown. Male without vocal sacs; thumb with black nuptial excrescences.

	♂. millim.	♀. millim.
From snout to vent	44	45
Length of head	14	14
Width of head	14	14
Diameter of the eye	4	4
Diameter of the tympanum	2·5	2·5
Length of the snout	5	5·5
Fore limb	24	26
Hind limb	68	69
Tibia	21	21
Inner toe	4·5	5
Inner metatarsal tubercle	1·5	1·5

15. *Bufo Raddii.*

Strauch, Voy. Przewalski, Rept. and Batr. p. 53; Bouleng. P. Z. S. 1880, p. 551.

Known from the Valley of the Amoor, Daouria, Peking, and Chefoo.

16. *Bufo vulgaris*, Laur.

Its eastern range extends over nearly the whole of China and Amoorland and Japan. The differences between European and Japanese specimens, which consist chiefly in the greater size and perfect distinctness of the tympanum, the black lateral stripe, and the deep black spots or marblings of the lower parts in the latter, are completely bridged over by the Chinese and Manchurian specimens. Specimens from Ichang, on the Yangtse Kiang, and Ningpo come nearest the Japanese, from which they do not differ in coloration;

but the tympanum, although as distinct, is not so large. Specimens from Shanghai, Chefoo, Peking, and Corea are intermediate between the latter and the European; the tympanum is always very distinct, but varies considerably in size; the dark lateral stripe is usually ill-defined or absent, and the belly may be either largely spotted with black or almost immaculate. Judging from the two specimens collected at Chabarowka by Hr. Dörries, the northernmost form is still nearer the European; the tympanum is rather small, but perfectly distinct, the belly is immaculate, and the coloration might be said to be identical with that of European specimens, but for the presence of traces of a light vertebral line, as is often found in specimens from Japan, Corea, and Northern China. The following table shows (in millims.) the variations in the size of the tympanum:—

	Denmark.	Jersey.	Chabarowka.	Corea.		Chefoo.	Ichang.	Japan.	
	♂.	♀.	♂.	♂.	♀.	♂.	♀.	♂.	♀.
From snout to vent......	76	125	65	88	120	87	102	120	132
Diameter of the eye	7	9	7	7	9	7	8	9	11
Diameter of the tympanum	2·5	4	3	3	6	4	5	7	8

17. *Hyla Stepheni.*

Bouleng. P. Z. S. 1887, p. 579, pl. li. fig. 1.

Of this species, recently described from a specimen received alive from Port Hamilton, Corea, by the Zoological Society, two specimens, male and female, from the Ussuri River, are in Hr. Dörries's collection. It is easily distinguished from *H. arborea* by the much larger and more prominent metatarsal tubercle. I give the following measurements of the two specimens:—

	♂. millim.	♀. millim.
From snout to vent..................	35	40
Length of head	12	13
Width of head......................	13	15
Diameter of the tympanum	2	3
Fore limb...	20	23
Hind limb	51	57
Tibia..............................	15	17
Inner toe	4	4
Inner metatarsal tubercle	2 5	2·5

18. *Bombinator orientalis.* (Pl. IX. fig. 2.)

The Oriental form for which I propose the above name agrees with *B. pachypus* in the proportions of the limbs and the absence of gular sacs, and with *B. igneus* in the absence of nuptial excrescences on the toes and the red colour of the lower parts. Nineteen specimens are in the British Museum, viz. :—

1–11. ♂ ♀, nupt. temp. Chefoo. Swinhoe.
12–15. ♂ ♀, nupt. temp. N. China. A. Adams.
16. ♀. S.E. coast of Corea. A. Carpenter.
17–19. ♂ ♀, nupt. temp. Chabarowka. Dörries.

Measurements.

	Chefoo.		Chabarowka.	
	♂.	♀.	♂.	♀.
	millim.	millim.	millim.	millim.
From snout to vent	52	46	36	40
Head	16	14	12	13
Width of head	18	16	13	13
Fore limb	26	23	20	20
Hind limb	61	55	49	59
Tibia	18	16	15	15
Foot, from inner metatarsal tubercle	16	15	14	14

The upper surfaces are usually as coarsely warty as in *B. pachypus*. As in *B. igneus*, the upper parts are always spotted or marbled with darker and show no trace of the four light spots of *B. pachypus*; the ground-colour varies from a dull olive with few and somewhat ill-defined darker spots to a bright green handsomely spotted or marbled with deep black. Lower parts blood-red, spotted or marbled with deep black, usually neither of the two colours predominating; no white dots on the belly; tips of fingers and toes red.

The distinctive characters of the three species of *Bombinator* may be analysed as follows :—

	Crus.	Gular sacs.	Nuptial excrescences.	Belly more	Tips of digits.
1. *igneus*	Shorter than foot.	Present.	None on toes.	Red.	Black.
2. *orientalis*	At least as long as foot.	Absent.			Bright.
3. *pachypus* ..			On toes.	Yellow.	

From this analysis we see that *B. orientalis*, although intermediate between *B. igneus* and *B. pachypus*, is on the whole nearer the latter. So far as we know, the enormous area separating the habitats of *B. igneus** and *B. orientalis* does not seem to be tenanted by any form of the genus *Bombinator* or any other Discoglossoid.

Caudata.

19. *Salamandrella Keyserlingii.*

Dybowski, Verh. zool.-bot. Ges. Wien, 1870, p. 237, pl. vii.
Isodactylium Schrenckii, Strauch, Salam. p. 56, pl. ii. fig. 1.

Lake Baikal, Schilka and Ussuri Rivers. Specimens from Chabarowka are in Hr. Dörries's collection.

20. *Geomolge Fischeri.*

Bouleng. P. Z. S. 1886, p. 416, pl. xxxix. fig. 2.

The only specimens known of this very remarkable Salamandroid are the two types obtained by Hr. Dörries at Chabarowka.

XVIII.—*Notes on some Heliozoa.* By M. Eug. Penard †.

The Heliozoa are most frequently met with in the fresh water of pools, peat-mosses, and brooks. Although these organisms were observed during the last century (Joblot, O. F. Müller, Eichhorn) it is only within about thirty years that they have been well known. Classed for a long time with the Infusoria, they were grouped by Häckel in 1866 into a special subclass. By their particularly elegant forms and their whole organization the Heliozoa, by showing us to what degree of differentiation a simple Rhizopod may attain, fully deserve the interest which has attached to them, and it is to them that I would for a moment call attention.

These animals are in reality only Rhizopods; but while in

* Not recorded east of the Ural. *B. pachypus*, which inhabits the plain in the west of Europe, appears to be exclusively a hill-form in the east; it is not known from Russia.

† Communicated to the Société de Physique et d'Histoire Naturelle de Genève, 3rd October, 1889; Bibl. Univ., 'Archives des Sciences Physiques et Naturelles,' tome xxii. pp. 523–539.

their near Amœbiform relatives the tendency towards perfection is in general directed to the acquisition of a rigid capsule open at one point to allow the passage of the pseudopodia, as is seen in the carapaces of the *Difflugiæ*, *Arcellæ*, *Euglyphæ*, &c., in the Heliozoa we may say that this tendency has led towards the possession of a coat of mail surrounding the whole body, and from which issue in all directions long radiating pseudopodia.

The external envelope, however, in some of them still consists only of a thick layer of hyaline plasma, which, in the Actinophrydians, is marked by large vacuoles; in others (*Lithocolla*) this hyaline layer is covered with stones derived from the medium in which the animal lives; in the *Clathrulinæ* we find an elegant solid trellis-work, formed throughout by the individual and pierced on all sides; but in the majority of the species we meet with a true coat of mail, the mobile elements of which, siliceous scales and spicules, are buried in the external mucilaginous layer which has just been mentioned.

The pseudopodia are always remarkable for their fineness, their rigidity, and their length; in this respect they differ at the first glance from those of the Amœban Rhizopods, whether naked or testaceous, although in some of the latter (*Euglypha*, *Trinema*, *Cyphoderia*, &c.) they may also be very long, very fine, and comparatively rigid.

All the true Heliozoa have at least one nucleus, sometimes two, or even more, but in general unity is the rule; *Actinosphærium Eichhornii*, on the other hand, constantly contains a considerable number, up to one hundred or more.

This nucleus likewise always possesses what has been called a vesicular structure, which also occurs among the Amœbæ; passing from the centre towards the periphery, it consists of a voluminous central body, surrounded by a thicker or thinner zone of hyaline substance (the nuclear fluid), liquid in appearance, and in its turn bounded by a true nuclear membrane, rather thick in the Actinophrydians and very delicate in the other Heliozoa. As to the central mass of the nucleus, generally regarded as the nucleolus, it is most frequently simple; but sometimes we find it divided into several fragments immersed in the nuclear fluid.

The nucleus, taken as a whole, is central in some species, excentric in the majority, but it always belongs nevertheless to that part of the plasma which has been called endosarc, to distinguish it from a generally less homogeneous, more granular zone, which, however, is often absent or impossible to distinguish from the former, and to which the name of ectosarc is given.

In this brief general description of the Heliozoa we may mention lastly the more or less numerous vacuoles which appear and disappear irregularly in the mass of the plasma, and the more differentiated contractile vesicle, which probably is not deficient in any Heliozoon. This vesicle presents phenomena of diastole and systole, slowly increasing in volume and then suddenly contracting. Frequently we only see one of them; but I have remarked that even in the species which normally have only a single one we may always expect to find individuals which have several; thus the number of the contractile vesicles, in my opinion, is only of very secondary value in the determination of species.

I wish at present to treat only of some points in the anatomy of the Heliozoa and of some still imperfectly known phenomena in the life of these animals. In fact at Wiesbaden, a locality which has proved to be very rich both in species and individuals, I have had the opportunity of studying most of the forms which have hitherto been described, and my observations have been made upon a number of individuals so considerable that I have been able to arrive at conclusions deserving of some interest.

In the first place I shall say a few words upon the protective covering of certain typical forms. In *Actinophrys sol* it is the vacuolized ectosarc which performs the part of the envelope; the body is surrounded by a layer of vesicles, which, by their mutual pressure, often form a regular pattern of cells with the walls formed simply of hyaline plasma. In *Actinosphærium Eichhorni* the case is again the same, but the layer of cells is more regular, so that, under a low power, the ectosarc appears like a wide clear band traversed by radiating striæ, these striæ only representing the walls of the cells.

If now we pass at once from the Actinophrydians to the great family of the Acanthocystidæ we find a very different structure. The central mass of the body is still surrounded by a mucilaginous envelope, but without vacuoles; and this envelope itself seems to be doubled, the narrow inner zone remaining homogeneous and clear, the outer one containing a considerable number of small tangential scales, which are sufficiently close together to lead to the belief in a continuous membrane, or may even overlie one another; besides these tangential scales we find, immersed in this external zone of the envelope, the bases of the radial spicules to which we shall refer hereafter.

Now most authors, who, it must be said, seem to have the idea only of a continuous membrane where there are in reality only free scales plunged in a mucilage, have regarded either this membrane or the narrow clear zone of plasma which lies immediately within it as a sort of exudation of the central plasma of no particular importance; and as, on the other hand, this central plasma is really often seen split into two concentric zones, the two latter have, in the Acanthocystidæ, been denominated the ecto- and endosarc.

In my opinion we have here a confusion. In fact I have been able to ascertain that the skeletal mucilaginous zone is perfectly active, and behaves physiologically—for example, during the capture of prey—like the vacuolized ectosarc of *Actinophrys*. I should therefore be inclined to regard it as the true ectosarc. It is true that this opinion is open to dispute; but as I have referred to it at greater length elsewhere *, I shall not dwell upon it here; moreover the sequel of this communication will contain some explanations of this point.

Let us return to the skeleton properly so called, to the siliceous spicules, and take as an example one of the largest species, *Acanthocystis turfacea*, Carter, which is best fitted for observation.

The skeleton of a *typical* and adult *Acanthocystis turfacea* is composed of siliceous elements of three forms:—

a. Of thick, very short, tangential scales, giving rise by their combination one after the other to the appearance of a continuous membrane;

b. Of large radial spicules, bifurcate at the apex, and terminated like nail-heads at the base, nearly equalling in length the diameter of the animal itself; and

c. Of smaller radial spicules, exceedingly fine, widely bifurcated at the apex, intercalated among the large spicules.

The structure of these spicules is not well known, and therefore I may venture to dwell upon them for a moment. Having had the opportunity of observing a great number of individuals of different ages, I have in the first place ascertained certain points, which may be summed up as follows:—

a. The long spicules of *Acanthocystis turfacea* are thicker, more definite, and longer in proportion as the animal is older.

b. In the young we see only the stem of the spicule, which is fine and not well defined; the nail-head of the base and the fork at the apex are not visible (do not exist?).

* 'Archives de Biologie,' tome ix. (1889).

c. The chief body of the spicule is already perfectly distinct when the base and the head are still scarcely so.

d. In the adult the base and the fork at the apex always remain more indistinct than the body of the stem; the fork, of a dull blue colour, is, as it were, implanted upon the stem, which seems as if truncated behind the bifurcation.

e. The body of the spicule perfectly resists concentrated sulphuric acid, as also a red heat, while the head and the base disappear; but after the action of these reagents the spicule is then traversed in this species by a central line, which is brownish by refraction and seems to show that it is hollow, as indeed Greeff has already stated.

f. The spicule, especially when young, seems to be covered with a very fine mucilaginous varnish. This may be inferred from the appearances in the living animal, then after simple desiccation, and finally in glycerine, or from the effects produced by the action of an acid.

From these observations, checked by others made upon three different species (*Acanthocystis aculeata*, *erinaceus*, and *albida*) which have given me the same results, I think it is permissible to draw the following conclusion:—"The spicules of the *Acanthocystides* are clothed, at least during the time of their growth, with a mucilaginous varnish, within which they are formed. Their growth takes place at the same time at the base and at the apex."

I may add that, having found in January last in one of my bottles a great quantity of young individuals belonging to *Acanthocystis albida*, sp. nov., and examined them from time to time, at each observation I found their radial spicules more vigorous, so that in three months their thickness and length were nearly double what they were at the first observation; later on these animals remained stationary and died in water which no longer furnished them with food. As there is scarcely any doubt that I had constantly to do with the same generation, we must infer from this that these animals took three months at least to arrive at the adult state, and that their life is consequently tolerably long.

Another point in the physiology of the Heliozoa which is still obscure regards the movements of the animal, and leads me to say a few words on the pseudopodia.

Here again we find a well-marked difference between the Actinophrydians, that is to say the genera *Actinophrys* and *Actinosphærium* on the one hand, and the rest of the Heliozoa on the other. The pseudopodia of *Actinophrys* consist of a hyaline axial thread, which, however, is rarely visible, covered by a layer of greyish plasma, rather thick at the base and very fine at the apex of the pseudopodium, and in which regular but very slow movements of granules have been recognized. The axial thread, which may be seen even in the interior of the inner plasma of the animal, where it abuts against the nuclear membrane, presents the curious phenomenon that under certain circumstances it may completely dissolve and disappear from sight, to reappear an instant afterwards. Hitherto we have not succeeded in explaining this phenomenon; some authors have imagined an actual retreat, in which the thread would roll up upon itself, but this attempt at an explanation cannot be sustained, for besides that one would easily see the thread in the rolled-up state, I have several times in compressed specimens witnessed the slow dissolution of this thread, the outlines of which, gradually losing their distinctness at the same time throughout the whole length of the thread, finally disappeared completely at the same time that the pseudopodium became Amœboid. Perhaps we have here only what may be called a voluntary and facultative hardening of the axis of the pseudopodium, resembling what takes place at the surface of the body of the Amœbæ and other Protozoa in which the ectosarc is viscous or, on the contrary, resistant and non-glutinous at will.

The pseudopodia in their entirety present very interesting phenomena; at one moment rigid and elastic, like steel wires, they will become all at once soft and indifferent, without, however, always changing their form; exposed to a shock (produced, for example, by a violent stream of water), they will retract themselves suddenly into a single mass, to push out again in a few minutes and attain a length double that of the body. The pseudopodia of *Actinosphærium*, shorter relatively to the diameter of the animal, are absolutely similar to those of *Actinophrys*, as indeed is the case with the whole animal, which differs so little from the latter, that I have often been tempted to derive it from a simple colony of *Actinophrys*, but a colony fixed as such in the sequence of generations and resembling the colonial Radiolaria.

As to the pseudopodia of the *Acanthocystides*, they are distinguished from those which we have just been considering by a much more considerable fineness and at the same time by a much greater comparative length. They are composed of a rigid thread, upon which are sprinkled small granules of grey plasma, united to each other no doubt by a sort of protoplasmic varnish. The granules, with the varnish, would then represent the greyish covering of the pseudopodia of *Actino-*

phrys. As to the rigid threads, they have been seen to traverse the body of the animal and to converge towards a common centre, where there was a central granule brightly stained by carmine.

In other respects the pseudopodia of the *Acanthocystides* present the same phenomena as those of *Actinophrys*; they are rigid or soft according to circumstances, and they retract suddenly upon themselves during the passage of a stream of water, forming globules like those of a thread of glass exposed to a flame.

It is by means of these long pseudopodia that the Heliozoa move upon the mud or run over aquatic plants. The Actinophrydians, however, most frequently appear motionless; but sometimes, for example when a colony breaks up, the individuals are animated by a perceptible movement; we then see that they pull upon their anterior pseudopodia, the points of which they have stuck to the soil, while the posterior ones drag behind, become elongated by traction, and finish by detaching themselves and shortening. The lateral pseudopodia, also fixed to the soil by their points, likewise drag a little behind, so that from the general appearance of the animal we can foresee the point at which it will finally arrive.

As to the *Acanthocystides*, the movements of which are sometimes so rapid that they traverse in one minute a course equal to ten or twelve times their diameter, I have succeeded after a very careful examination in explaining them in the following manner:—The animal, resting on its pseudopodia like a cursorial spider upon its legs, throws out in front some of these pseudopodia; these attach themselves to the soil by their points, which are at the moment viscous and perhaps also slightly dilated into heads; then, stiffening, they draw the animal towards them; the body, while advancing slightly, turns a little upon itself from behind forwards, probably because the cords or pseudopodia which drag it originate above the equator of the animal; new pseudopodia, always antero-superior, then attach themselves by their points in front of the former ones and stiffen in their turn. This movement continuing and the anterior cords pulling while the posterior ones detach themselves one after the other, often with a small sudden shock, and the lateral ones seeming to steady the whole, the animal progresses by rolling continually over and over, so that, by transmitted light, we see all the excentric elements, prey or granules, contained within the body traverse this body in a straight line, at first from behind forward and then from in front backwards. It must be remarked that during locomotion the body appears to turn much too slowly relatively to the distance travelled—that is to say that, instead of traversing a space equal to about three times its diameter in a complete turn, it is not until after executing a much longer passage that a complete revolution has been made; this is because the sphere which may be imagined as circumscribing the animal is not represented by the body itself, but rather by the extremities of the pseudopodia.

Such, according to my observations, is the process of locomotion in the Heliozoa; and this explanation would confirm the opinion of Hertwig and Lesser, who, in a memoir, of which, however, I had no knowledge until long after arriving at my own conclusions, have described a Heliozoon as "rolling after the fashion of a ball and by the contraction of the pseudopodia."

The pseudopodia of the Heliozoa, besides their functions as locomotive organs, also play a certain part in the capture of prey. In *Actinophrys* the little organisms which have fallen among the pseudopodia as into a spider's web glide along these threads until they arrive quite close to the body, at the same time that a portion of plasma issuing from the ectosarc advances to meet them, encloses them, and keeps them for whole hours in a large vacuole full of liquid, in which they are digested. The pseudopodia themselves may be active in so far that they bend round the captured prey and draw it on; but this fact, although certain, is much more rare than is generally supposed.

In the *Acanthocystides* the phenomenon of the capture of prey is still more interesting, and is at present known only in its broad features. After having studied it in half a dozen species I can describe it as follows, again taking *Acanthocystis turfacea* as an example.

When a small organism, such as a Monad for example, comes in its course in contact with an *Acanthocystis*, the radial spicules of the latter separate and lie down, at the same time that a depression is formed at the spot upon which the prey has fallen; the bases of the spicules then change their position, moving in the very body of the mucilaginous layer which bears them, and gain the margins of the depression, where the spicules are soon seen accumulated in disorder; the tangential scales do the same, and the whole mucilaginous mass separates, thus leaving an opening in which the prey finally comes into direct contact with the interior body or so-called ectosarc of the *Acanthocystis*. At this moment the withdrawn mucilage begins to show an active movement all round the Monad, and finally englobes it completely; the spicules ascend on their part, and the tangential scales, completely immersed in the mucilage, arrive at the top before the radial spicules, although after the complete closure of the mucilaginous arch. It is very interesting to see the scales advance, one after the other, in this hyaline envelope, in which they seem to swim, as it were in midwater, as if by a movement proper to them; the radial spicules, having their base only immersed in this envelope, appear to have more resistance to overcome and arrive at the top more slowly; nevertheless they reach it, and, after a moment of confusion, resume their relative positions, and the *Acanthocystis* is then again completely covered by its coat of mail, and an observer coming upon it at this moment might wonder by what means so large a prey could have penetrated beneath the membrane. The whole phenomenon scarcely lasts more than a minute.

As to the kind of nourishment of the Heliozoa, this is variable according to the medium; we see some which are stuffed with microscopic Algæ, Diatomeæ, Desmidieæ, &c.; but in general they seem to prefer to capture small animals, Monads, Vorticellæ, Rotifera, &c. *Actinophrys*, in particular, consumes an incredible number of the latter, and does not always capture them without trouble.

There is much more to be said upon the physiology and constitution of the Heliozoa. I have not mentioned the bodies of different nature contained in the internal plasma, such as grains of starch, chlorophyll, &c., nor the phenomena of multiplication (fission, conjugation, budding, spores), nor the siliceous cysts into which the animals withdraw, nor the colonies which certain species like to form. All this would lead us rather too far *. I prefer at present to add a few words upon certain organisms which may show us points of approximation between the Heliozoa on the one hand and the Monera, Amœbæ, and even the Flagellata on the other.

The first of these organisms is *Vampyrella spirogyræ* of Cienkowski. Häckel has classed the *Vampyrellæ* among the Monera, or Rhizopods destitute alike of nucleus and of contractile vesicle; of late, indeed, very numerous grains of chromatine or of nuclear substance have been discovered in several organisms which had previously passed as devoid of nucleus;

* I would nevertheless revert to certain very brilliant blue grains, sometimes very large, enclosed within the body of the *Acanthocystides*, the signification of which I have discussed in the second part of my memoir on the Heliozoa (Arch. de Biologie, tome ix.). For some time I have come to the conclusion that we had to do here simply with grains of starch. Now, a few days ago, having opened a glycerine-preparation in which I preserved one of these large grains, I treated the latter with iodine, and saw it immediately acquire a fine violet colour. It is therefore starch, and my first suppositions were erroneous.

and in some individual *Vampyrellæ* it appears that Zopf has found a true nucleus. But Häckel's classification still retains a great systematic value. As regards the *Vampyrellæ*, I do not know whether the authors who have made them Heliozoa (*e. g.* Bütschli, in his fine work on the Protozoa) have not attached too great importance to mere external resemblances.

Vampyrella spirogyræ, in its normal state, is a small Rhizopod of about 40 micromillimetres in diameter, spherical, of a fine brick-red colour, devoid of nucleus and contractile vesicle, but containing in its ectosarc a great quantity of small non-contractile vacuoles. From the exterior radiate a considerable number of pseudopodia, some long and covered with granules, the others very short and as if terminated by pins' heads, the last appearance being due to the fact that, especially when the animal is progressing, very small hyaline spheres run constantly over these pseudopodia, seeming positively to be thrown out by the animal and to fall again immediately at the very point from which they were expelled. The phenomenon of these little balls springing up on all sides is so extraordinary that when I had this species under my eyes for the first time I thought I could not do better than name it provisionally the "*Vampirelle jongleuse*;" subsequently I found that it had been described and even bore two names—*Vampyrella lateritia* in consequence of its colour, and *Vampyrella spirogyræ*, after the plant from which it prefers to obtain its nourishment.

It is upon the manner in which this species acts in order to empty the cells of the *Spirogyræ* that I wish to say a few words here; in fact my observations have led me to an explanation different from that usually given. The *Vampyrella* is said to pierce a hole in a cell of *Spirogyra* and to introduce into it a pseudopodium, the business of which is to search the contents of the cell. For my part this is how I can describe the phenomenon which I have observed repeatedly, always arriving at the same conclusions:—The *Vampyrella* attaches itself to a cell of *Spirogyra*, retracts its pseudopodia, except a few by which it adheres to the Alga, and then moulds itself to the cell upon a portion of its surface, and becomes motionless. For a moment nothing takes place; then we see the attached zone rise up into an arch in the interior, the margins remaining firmly attached and formed into a ring; the arch gradually rises, and suddenly the wall of the Alga bursts, the cell-juice of the *Spirogyra* passes in a violent stream into the *Vampyrella*; the greyish plasma of the cell passes in its turn more slowly, with the green chromatophore, which is seen to glide in a mass; the cell is completely emptied, the *Vampyrella* emits pseudopodia, becomes detached, and moves away, leaving a very visible rupture in the empty cell. It then often goes to the next cell, or even to a third, and, having emptied these in the same manner and become greatly enlarged, it encysts itself. At this moment it has lost its brick-red tint, which is at the utmost visible here and there in spots in the greenish mass with which its body is stuffed. Later on it will divide within its cyst into several embryos, which will pierce a hole and issue one after the other, already clothed in their fine red colour.

To return to the nutrition of the *Vampyrella*: this is effected, in my opinion, by a true phenomenon of suction, the whole body of the animal acting as a sucking-cup; what would seem to be opposed to this view is that the cell of the Alga as it is emptied does not flatten under the pressure of the surrounding liquid; but it is possible that the cell, as it loses its original contents, gets filled with water through the partition which separates it from the following cell, or even through the whole of its own wall.

Another organism to which I wish to call attention is a new form of Heliozoon which I have met with this summer in considerable abundance, but only on one occasion. The body, which is very small (about 15 micros) and of a reddish tint, is normally spherical, but is subject to very rapid deformations of considerable amount, though always tolerably thickset and retaining its distinct outline; the ectosarc, a thin lighter band, is traversed by a line of very small tangential spicules, but has no radiating ones; the pseudopodia, which are hyaline, sparingly granular, excessively long, filiform, and thicker at the base than at the apex, are in very small number. The animal runs like a spider by means of its pseudopodia, leaping to one side or straight forward with surprising agility, so that it progresses almost as rapidly as a Flagellate. It has sometimes appeared to me even to swim freely in the water, and can at any rate beat with its pseudopodia, which, however, have nothing to do with real flagella. This organism possesses an excentric nucleus in a clear endosarc, and a contractile vesicle. There is no doubt that it is a true Heliozoon, which resembles some *Amœbæ* in the plasticity of its body and in the nature and restricted number of its pseudopodia (*Amœba radiosa*).

Lastly, I have a few words to say upon another organism which I also found in abundance this summer at Wiesbaden, but only in a single locality. It is a true Monad, spherical, of small size (10–15 micros), with two very clear flagella which I have often seen beating and drawing food into a depression or mouth opening near their base. But what distinguishes this Protozoon from the Flagellata in general is the possession of numerous filiform, rigid, straight pseudopodia covered with granulations, in fact similar to those of the *Acanthocystides*, and by means of which the animal attaches itself to the ground and moves slowly. This organism is furnished with a central nucleus and a contractile vesicle, and can feed equally by the whole of its surface, after the fashion of the Heliozoa. Although this Protistan must be regarded as a Flagellate, it seemed to me to be of interest to mention it here, as it appears to have acquired certain elements characteristic of a very different group of Protozoa.

XIX.—*Description of a new Species of* Sorex *from Saghalien Island.* By G. E. Dobson, M.A., F.R.S.

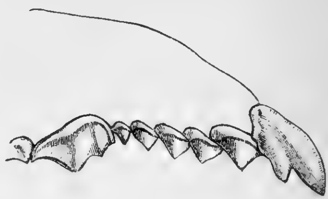
The following description of the largest species of the genus *Sorex* as yet known to inhabit the Eastern Hemisphere is derived from an examination of four specimens, two adult females preserved in alcohol and two skins with skulls, which form part of the collection of the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg.

Sorex unguiculatus.

Larger than *Sorex alpinus*, but with a considerably shorter tail, and distinguished from every known species of the genus by the extraordinarily large size of the manus and its claws, which have their parallel only in *Crocidura macropus.* In the shape of the head, body, and tail this species resembles *S. vulgaris*; the tail is clothed evenly with short, rather stiff hairs, which do not form a pencil at the extremity; the fur is dark brown above, on the under surface the extremities of the hairs are ashy; the dorsal surface of the manus is clothed with a few short, shining, grey hairs, but the digits are naked and the rings of integument are divided into tubercles, not entire as in *S. vulgaris.*

The manus and pes are very large, especially the former, which greatly exceeds that of *S. vulgaris* both in breadth and in length, the claws of the three middle digits being nearly as long as the digits without claws; on the other hand those of the digits of the pes are not unusually large.

The skull differs altogether from that of *S. vulgaris* in its much greater width between the mastoid processes and also in the proportions of the teeth. The second incisor is the most vertically extended and largest of the upper unicuspidate teeth, presenting in this respect a character almost peculiar to the species; the third unicuspidate tooth is about the same size as the second, but considerably exceeds the fourth unicuspidate tooth in vertical extent; the penultimate premolar stands in the tooth-row and is nearly as large as in *S. alpinus*. These are the characters of the teeth in the four specimens available for examination; but, owing to all being examples of full-grown animals, the cusps are more or less worn, so that it is impossible to give their exact relative size.



× 7.

The following are the measurements of an adult female specimen preserved in alcohol:—Length, head and body 68 millim.; tail 53; eye from end of muzzle 12; ear, length 7; elbow to end of middle digit, without claw, 20; manus to extremity of middle claw 11; ditto, without claw, $8\frac{1}{2}$; pes 14; distance between tips of first upper incisor and last premolar 5.

Hab. Saghalien Island; Nikolajewsk, at the mouth of the Amur River.

Type, an adult female, No. 1535, preserved in alcohol in the St. Petersburg Museum, collected by Dr. L. von Schrenck.

This species by its dentition belongs to that section of the genus characterized by the large size of the penultimate premolar, which also stands in the tooth-row, and of which *S. alpinus* and *S. minutus* are typical; but it differs, as above remarked, from all known species in the remarkably large size of the manus and its claws.

XX.—*Divergent Evolution and the Darwinian Theory.* By Rev. John T. Gulick, Ph.D.*

In a paper on "Divergent Evolution through Cumulative Segregation" (Journ. Linn. Soc., Zoology, vol. xx. pp. 189–274) I have endeavoured to show that selection, whether natural or artificial, is a process that has no tendency to produce divergent evolution, unless different sections of one

* From the 'American Journal of Science,' January 1890, pp. 21–30.

original stock are subjected to different forms of selection, while at the same time some cause prevents free crossing between the different sections. We now inquire whether Darwin has made us acquainted with any cause or combination of causes that, without the aid of man, produces diversity of selection and at the same time the independent generation of the different classes of variations thus preserved.

Darwin discusses the causes of natural selection more fully than the causes of diversity of natural selection. He does not speak of uniformity and diversity of natural selection, but of the individuals of the same species living under the same external conditions as being modified in the same way, and of those living under dissimilar external conditions as being modified in different ways. Again, he speaks of "the divergent tendency of natural selection," resulting from "the principle of benefit being derived from divergence of character," as explaining divergence of character in the members of one species competing with each other on a common area. How the contradictions in the two statements are to be reconciled, and how, in the second case, the unifying influence of free crossing is prevented, he does not show, so far as I can discover. As the subject is of the highest importance in the explanation of divergent evolution, and as it is specially desirable to get as clear an understanding as possible of Darwin's method of explanation, I shall consider his reasoning somewhat fully.

Same Degree of Local Separation under Different Environments.

Darwin often speaks of the influence of crossing in retarding or preventing the formation of new races and species; but, from the following extracts from his 'Origin of Species,' it will be seen that it is not quite so clear what combination of causes he considered necessary for the production of two or more species from one original species. The obscurity in his statements results, I think, from the fact that "a new species" may be one that has been formed by monotypic transformation, the old form disappearing with the production of the new, or it may be one that has arisen through polytypic transformation, which is the modification of one branch of the species, while other branches remain either unmodified or modified in other ways. For the formation of a new species, in the former meaning of the word, he evidently did not consider it necessary that the species or any part of it should enter a new environment or that crossing should be prevented. But did he not consider both these conditions necessary for the formation of two or more species from one original species?

He says, "Intercrossing will affect those animals most which unite for each birth and wander much, and which do not breed at a very quick rate. Hence with animals of this nature, for instance birds, varieties will generally be confined to different countries; and this I find to be the case. With hermaphrodite organisms which cross only occasionally, and likewise with animals which unite for each birth but which wander little and can increase at a very rapid rate, *a new and improved variety might be quickly formed on any one spot*, and might there maintain itself in a body and afterward spread, so that the crossing would be chiefly between *the individuals of the new variety living together in the same place*. . . .

"Even in the case of animals which breed slowly and unite for each birth, we must not assume that *the effects of natural selection* will always be immediately overpowered by free intercrossing; for I can bring a considerable body of facts showing that within the same area varieties of the same animal *may long remain distinct*, from haunting different stations, from breeding at slightly different seasons, or from varieties of the same kind preferring to pair together. . . .

"Isolation also is an important element in the changes effected through natural selection. *In a confined or isolated area, if not very large, the organic and inorganic conditions of life will be almost uniform; so that natural selection will tend to modify all the varying individuals of the same species in the same manner*. Intercrossing with the inhabitants of the surrounding districts will also be prevented. Moritz Wagner has lately published an interesting essay on this subject, and has shown that the service rendered by isolation in preventing crosses between newly formed varieties is probably greater even than I have supposed. But, from reasons already assigned, I can by no means agree with this naturalist that migration and isolation are necessary for the formation of new species." ['Origin of Species,' fifth edition *, Chapter IV., Section on "Circumstances favourable for the Production of New Forms through Natural Selection."]

Again, in the same chapter, in the section on "Various Objections," in answer to the question "How, on the principle of natural selection, can a variety live side by side with the parent-species?" he replies, "If both have become fitted for slightly different habits of life or conditions they might live

* The same passages occur in the sixth edition, pp. 80, 81.

together, though in the case of animals which freely cross and wander much about *varieties seem to be almost always confined to distinct localities.* But if we put on one side polymorphic species, in which the variability seems to be of a peculiar nature, and all mere temporary variations, such as size, albinism, &c., the more permanent varieties are generally found, as far as I can judge, *inhabiting distinct stations, high land or low land, dry or moist districts, or distinct regions*" *.

In the portions of these passages which I have distinguished by italics Darwin seems clearly to maintain that for the formation of coexistent permanent varieties some degree of local separation is necessary. I therefore conclude that when he says he cannot regard migration and isolation as necessary for the formation of new species he intends to express, in opposition to Moritz Wagner, the opinion that a species may be transformed into a new species without leaving its original locality, but that he does not intend to say that two or more divergent species can arise in the same locality from the same stock. If I interpret him rightly he considers the partial separation described in the first of the paragraphs just quoted as sufficient to allow of the formation of divergent species, when the external conditions of the separate districts are sufficiently different and sufficiently permanent to secure long-continued divergent natural selection. That the second paragraph is to be interpreted in accord with this meaning I judge from the fact that natural selection is mentioned here as the cause of the divergence which crossing tends to overpower, and in the third paragraph uniformity in the environment is represented as ensuring uniform natural selection. The varieties that are restrained from crossing with each other by diverse times and habits of breeding he must regard sometimes as slightly divergent forms tending to disappear under the pressure of uniform natural selection, and therefore never becoming separate species, though one of them may prevail and be established as a new species, and sometimes as forms that are becoming more and more divergent, because they have found their way into districts or stations where they are somewhat separated from each other, and where the conditions are somewhat different, and the natural selection, therefore, somewhat diversive.

If this is not his meaning, if he intends to teach that forms arising in one place and not locally separated from each other can continue to diverge till they become separate species,

* In the sixth edition this passage will be found, slightly modified, in Chapter VII. p. 169.

how can he say on the next page that forms isolated in a small area, being exposed to uniform conditions, would be modified by natural selection in a uniform manner? He evidently does not intend to be understood as teaching that in these cases mentioned in the second paragraph there is a cause of divergent evolution which produces separate varieties and species in spite of the unifying influence of natural selection resulting from uniform conditions.

Darwin's Theory of Natural Selection through the Advantage of Divergence of Character.

There is, however, one passage in the 'Origin of Species' which may be interpreted as assigning a cause for divergence of character in representatives of the same species that are surrounded by the same environment. These are the words:—"Only those variations which are in some way profitable will be preserved or naturally selected. And here the importance of the principle of benefit being derived from divergence of character comes in; for this will generally lead to the most different or divergent variations being preserved and accumulated by natural selection." ('Origin of Species,' Chap. IV. first page of the section on the "Probable Results of the Action of Natural Selection, through Divergence of Character and Extinction, on the Descendants of a Common Ancestor." In the sixth edition this passage occurs on pp. 90–91.) The connexion in which this passage stands seems to indicate that "the benefit derived from the divergence of character" is considered the cause of "the most different or divergent variations being preserved and accumulated by natural selection," even in the case of the representatives of the same species that are competing with each other on the same area, and are in no way prevented from intercrossing. It is therefore necessary to show the difficulties that beset such a theory, especially if we adhere to the more general theory that diversity in the kinds of natural selection affecting a species must be due to differences in the environments by which it is surrounded.

In the first place natural selection, which is the superior propagation of those best adapted to the environment, prevents the interbreeding of the adapted forms that propagate with the unadapted that fail of propagating; but it can never prevent the interbreeding of those forms which, through different kinds of adaptation to the environment, survive and propagate, and therefore it can have no influence in producing accumulated divergence, unless it is supplemented by some segregative principle that prevents the different kinds of adaptations from being interfused. In the second place, as long as we follow Darwin's explanation of the causes of natural selection, we must hold that the representatives of one species while surrounded by the same environment, whether prevented from intercrossing or not, will, through the uniform action of natural selection, be modified in the same way, if at all, and, while surrounded by distinct and dissimilar environments, will be modified in divergent ways; but in this latter case, as they will be prevented from competing with each other by occupying different areas, they can derive no advantage from divergence of character through its preventing competition; therefore the divergence that follows must be attributed to some other cause. In other words, the advantage attributed by Darwin to divergence of character is freedom from competition, through diversity of adaptation, and, as some degree of prevention of crossing is necessary for permanent difference in adaptations, the advantage cannot be secured unless there is some cause preventing the crossing of the divergent forms. Now the prevention of crossing, if it ever arises, will be secured either while the individuals that are prevented from interbreeding are occupying the same limited area and exposed to the same environment, or while occupying distinct areas and exposed to either the same or different environments. In the first case we are told by Darwin that exposure to uniform conditions "will tend to modify all the varying individuals of the same species in the same manner." In the second case, as the sections of the species that are prevented from crossing occupy separate areas, the advantage of freedom from competition is already secured without divergent adaptation, and there can be no further advantage of that kind.

Again, it is not difficult to show that divergence is in itself no benefit, for multitudes of more divergent forms fail, leaving the field to less divergent ones. This is generally true of monstrosities and frequently true of other kinds of variations. Neither can it be claimed that freedom from competition is an advantage, unless it results in freer access to unappropriated resources, and this advantage is most frequently gained by migrating into a locality presenting the same environment, but not previously occupied by the species. In this last case the access to unappropriated resources does not depend on new adaptations; and, as any new adaptations that might bring advantage to the representatives of the species in one district would be of equal advantage in the other district, no divergence of character could be advantageous. It is this impossibility of advantage in divergence of character in portions of a species exposed to the same environment which leads many naturalists to maintain that isolation does not tend to produce divergence unless accompanied by exposure to different environments. But their reasoning is inconclusive, inasmuch as they have never shown that divergence depends on its being advantageous. In my study of Sandwich-Island mollusks I have found very strong reasons for believing that divergence may arise in the representatives of one species during exposure to the same environment, producing not only non-adaptive but also adaptive differences. But whether adaptive or non-adaptive, whether due to natural selection or to some other principle, differences that arise under the same environment cannot be advantageous differences, and the divergence through which the differences are reached is not advantageous divergence. It seems to me evident that neither is divergence always advantageous, nor is the advantage of access to unappropriated resources necessarily dependent on divergence; that neither does the accumulation of divergence depend on its being advantageous, nor is advantageous divergence always accumulated.

Darwin's Theory that Exposure to different Environments is Essential to Diversity of Natural Selection.

Diversity of natural selection in different portions of the same species depends upon diversity in the relations of the different portions to the environment. Now observation shows that cumulative diversity in the relations of the species to the environment may be introduced, (1) by dissimilar changes in the environment presented by the different areas occupied by the different portions; (2) by different portions of the species entering different environments; or (3) by dissimilar changes in the habits of the different portions of the species in using the same environment. Certainly in this third class of cases, if not in the other classes, without prevention of free crossing between the different portions there can be no cumulative diversity in relation to the environment, and therefore no cumulative diversity in the natural selection; and without the same condition there can be no accumulation of divergent effects of natural selection in any case. Darwin, however, forgetting the possibility of divergent changes in the habits of isolated portions of a species exposed to the same environment, maintains that exposure to different environments is essential to diversity of natural selection and to divergence. Without change in the climate, soil, or organic forms lying outside of the species, there is, according to him, nothing to produce modification.

"If a number of species, after having long competed with each other in their old home, were to migrate in a body into a new and afterwards isolated country, they would be little liable to modification, for neither migration nor isolation in themselves effect anything. These principles come into play only by bringing organisms into new relations with each other, and in a lesser degree with the surrounding physical conditions." ['Origin of Species,' on the fourth and fifth pages of the first chapter on "Geographical Distribution."]*

"Each separate island of the Galapagos Archipelago is tenanted, and the fact is a marvellous one, by many distinct species; but these species are related to each other in a very much closer manner than to the inhabitants of the American continent or of any other quarter of the world. This is what might have been expected, for islands situated so near each other would almost necessarily receive immigrants from the same original source and from each other. But how is it that many of the immigrants have been differently modified, though only in a small degree, in islands situated within sight of each other, having the same geological nature, the same height, climate, &c.? This long appeared to me a great difficulty: but it arises in chief part from the deeply seated error of considering the physical conditions of a country as the most important; whereas it cannot be disputed that the nature of the other species with which each has to compete is at least as important, and generally a far more important element of success. Now if we look to the species which inhabit the Galapagos Archipelago, and are likewise found in other parts of the world, we find that they differ considerably in the several islands." ['Origin of Species,' near the middle of the second chapter on "Geographical Distribution."] †

The implication in both these passages is that if the representatives of the same species are surrounded by the same organic forms, as well as by the same physical conditions in isolated countries, they will not undergo divergent modification. This is in complete accord with the third paragraph quoted near the beginning of this paper from the fourth chapter of the 'Origin of Species.'

Divergent Forms of Sexual Selection.

In the passages last quoted there is no mention of any exception to the principle that difference in external con-

* See ed. 6, p. 319. † See ed. 6, p. 355.

ditions is necessary to divergent evolution. No suggestion is given that through the action of sexual selection divergent species may be produced that are not at all dependent on differences in the environments, still there can be no doubt that this was Darwin's view. Though he does not directly discuss this problem in any passage I have been able to discover, he clearly expresses the opinion that the differences between the different races of man, and between man and the lower animals, are in no small degree due to sexual selection, and he never speaks of difference in sexual selection as depending on difference in the environment, though, at the close of the twentieth chapter of 'The Descent of Man,' he speaks of sexual selection in man as having probably "exaggerated" the "characteristic qualities" "which are of no service to" the tribes and races that possess them. The differences, however, in the races of man are attributed to sexual selection, not because of any lack of difference in their environments, but because the characters in which they differ do not seem to him to be related to the environment. The colour of the skin, hair, and eyes, and the different forms of the head and face, do not seem to be adapted to different conditions in the environment, while they are undoubtedly occasions of attraction or aversion for those seeking partners. He has not, however, shown whether the change of taste precedes the change of form and colour or the reverse. Differences between the sexes of the same species in secondary sexual characters are for weighty reasons attributed to sexual selection; but he does not show how this divergence between the sexes leads to the production of new species. This production of difference of character between the sexes, being in no way dependent on the prevention of crossing between the divergent sexes, must be a wholly different process from the production of races and species, which is absolutely dependent on prevention of crossing between the divergent races and species. There is nevertheless every reason to believe that when the representatives of a species capable of sexual selection are for many generations separated into groups that never cross, diversity of tastes is one of the forms of diversity that inevitably arises; but that the psychological divergence is the cause of the other correlated divergences is not so certain. The theory of divergence in races because of divergence in the forms of sexual selection seems to rest on the assumption that a psychological divergence may be accumulated and rendered permanent in a new and definite form without being subjected to selection; but if this is true of a psychological divergence, why may it not be true of any form of divergence? The difference in the ideals of beauty in different races is as important as difference in the skin and hair; and in accounting for the origin of races, it is quite as important to account for the former as for the latter; any theory that simply attributes the difference in the colour of the skin to difference in the ideal of beauty will be met by the suspicion that the difference in the ideal was preceded by the difference in the colour. My own strong conviction is that the true explanation is equally applicable to either set of phenomena.

Darwin's Reference to the Causes which Check the Crossing of Varieties.

In the second paragraph quoted from Darwin at the beginning of this chapter we find mention of three causes that may for a long time prevent the members of the same species from freely intercrossing while occupying the same area; but subsequent statements, in the same and the three succeeding sections, show that he regarded geographical and local separation as the forms of separate breeding that are most favourable to the production of new species. Moreover, in the two sections relating to "Divergence of Character," he seems to maintain that the prevention of intercrossing is not a necessary condition for divergence of character in members of the same species that are competing with each other *. In Chapter XVI. of his "Variation under Domestication" several causes that interfere with the free crossing of varieties are enumerated; but they are nowhere recognized as essential factors in the evolution of divergent varieties and species, without which diversity of natural selection would be of no avail, and with which divergence will take place though there is no change in the environment. They are looked upon as characteristics in which many varieties more or less resemble species; but they are regarded as the results rather than the causes of divergent evolution.

Conclusion.

We therefore find that though Darwin has not recognized segregation, which is the independent propagation of different

* In 'Nature,' vol. xxxiv. p. 407, Mr. Francis Darwin states that in his copy of Belt's 'Naturalist in Nicaragua' the words "No, No" are pencilled in his father's handwriting on the margin opposite the sentence: "All the individuals might vary in some one direction, but they could not split up into distinct species whilst they occupied the same area and interbred without difficulty." This seems to give a decisive answer concerning Darwin's opinion on this subject.

variations, as a necessary condition for the production of divergent races and species, he has pointed out one process by which segregation is produced in nature. This one process is geographical or local separation under different environments. It may be the result of migration or of geological and other changes in the environment; but, in either case, there is the preservation of different variations through diversity of natural selection due to the difference in the environments, and the independent propagation of the same variations due to their geographical or local separation. We have in this process an important cause of segregation resulting in divergent evolution; but no one can maintain that this is the only cause producing segregation and divergence, unless he ignores the fact that, in some cases, the isolated portions of a species, while exposed to the same environment, acquire divergent habits in the use of the environment, producing diversity of natural selection; and that, in other cases, without exposure to different environments, the very process producing the isolation brings together those of one kind, preventing them from crossing with those of other kinds, as when individuals of a special colour prefer to pair together. In the former cases indiscriminate separation is transformed into segregation; and in the latter cases the isolation is segregative from the first, while in both classes of cases the divergence is without exposure to different environments.

Osaka, Japan.

XXI.—*Description of a new Genus of Oriental* Cicadidæ. By W. L. Distant.

Talainga, gen. nov.

♀. Body somewhat elongate, the abdomen cylindrical. Head with the front globose and prominent, including outer margins of eyes about as broad as base of mesonotum; ocelli about twice as far apart from eyes as from each other. Pronotum with the lateral margins ampliated, deeply notched about centre, and then more broadly ampliated at posterior lateral margins. Anterior femora robustly spined. Tegmina talc-like, semiopaque, the whole apical area with the venation reticulate and forming a mass of small cell-like areas; in some specimens the ulnar areas are also crossed by transverse veins; interior ulnar area about same width at apex as at base; basal cell about twice as long as broad. Wings with the outer margin deeply sinuate near abdominal area; apical areas six, in some specimens broken up by transverse veins into a more numerous and reticulated series.

This diagnosis is founded on two female specimens, the structure of the abdomen implying that the tympana are uncovered in the male, thus locating the genus in my subfamily Tibiceninæ. *Talainga* is allied to *Gæana*, from which it is at once distinguished by the reticulated tegmina &c.

Talainga Binghami, n. sp.

♀. Body and legs black; eyes ochraceous, their posterior margins pale sanguineous; pronotum with the lateral margins and a curved spot on lateral areas behind eyes pale sanguineous, posterior margin—excepting extreme centre—narrowly ochraceous. Abdomen above with the marginal segments more or less greyishly pilose.

Tegmina talc-like, semiopaque, very pale ochraceous, the venation black and margined with the same colour, the apical area being thus composed of numerous small, black-margined, cellular areas; the costal membrane ochraceous, the basal cell shaded with black. Wings pale bluish green, the venation more or less concolorous, excepting that deliminating the more or less reticulated apical areas; posterior margin blackish from apex to the sinuation near abdominal area.

Long. excl. tegm., ♀ 23–26 millim., exp. tegm. 70–77 millim.

Hab. Burma, Kr. Hills (*Bingham*).

This beautiful genus is a great acquisition to our knowledge of the Eastern Cicadidæ. The type of coloration distinctly resembles that of *Tosena splendida*, Dist., which is also found in Burma, a country that has produced some of the handsomest insects of the whole family, and is still likely to contain many Cicadean novelties.

Talainga Binghami will be subsequently figured in my 'Monograph of Oriental Cicadidæ.'

XXII.—*Descriptions of two new Species of* Acræa *from Mombasa.* By H. Grose Smith.

Acræa crystallina.

Male.—Upperside. Both wings devoid of scales except at the apex of anterior wings, where they are narrowly brownish grey, narrowly irrorated internally with ochreous, and on the outer margin of posterior wings, where there is a row of ochreous lunules capped with grey between the veins; the spots and markings on the underside of posterior wings showing through; both wings tinged with brown at the base.

Underside. Posterior wings with the outer row of marginal lunules almost white, bordered all round with black; an irregular row of black spots across the disk; two black spots on the discocellular nervules, two others inside the cell towards the base, one above the subcostal nervure, one below the median nervure, two others below the submedian and internal nervures respectively, and one above the costal nervure, the last-named five spots all near the base; the space inside the precostal nervure, the base of the wings, and abdominal fold pink, shading to white.

The *female* resembles the male, but is rather larger.

Expanse of wings $2\frac{3}{8}$ inches.

Hab. Voi River, interior of Mombasa (*Last*).

Acræa uvui.

Male.—Upperside. Anterior wings bright fulvous-ochreous, with the base to the extent of one third of the wings, costal margin, apex, hind margin, and a broad transverse band from beyond the middle of costal margin to the middle of the hind margin black. Posterior wings same colour, slightly paler towards the abdominal fold, with the base and outer margin broadly black.

Underside. Anterior wings paler fulvous-ochreous, dusky towards the base, crossed beyond the middle by a black band as on the upperside; costal margin narrowly, apex and hind margin broadly, black. Posterior wings paler; a band of black spots before the middle, a cluster of black spots at the base; a rather broad marginal black band, in which, on the margin between the veins, is a row of ochreous lunules.

Female resembles the male, but less black at the base, and on the inner margin of the anterior wings, from the base to the middle, is a rather broad black band, and on the posterior wings the colour shades from the middle to the abdominal fold to pale ochreous.

Expanse of wings $1\frac{1}{4}$ inch.

Nearest to *A. eponina*, Cram.

Hab. Voi River, Mombasa (*Last*).

XXIII.—*Observations on some Coleoptera from the Bonin Islands.* By Charles O. Waterhouse and C. J. Gahan.

The British Museum has recently received a few Coleoptera collected by Herr P. A. Holst in the Bonin Islands. They are referable to three species, one being a new species of Buprestidæ of the genus *Chrysochroa*, most nearly allied to *C. purpureiventris* from Penang &c.; the second is a new species of *Ceresium*, which has its nearest ally in a Chinese species; and the third is the widely distributed *Sphenophorus obscurus*, Bdv.

Chrysochroa Holstii, n. sp., Waterh.

Elongata, angusta, aureo-viridis, micans; thorace crebre punctato, antice utrinque gutta cuprea notato; elytris postice bene acuminatis, creberrime punctatis, singulis costis quatuor lævibus instructis, apice purpureo-cupreo, angulo suturali acute dentiformi.
Long. 13 lin.

Hab. Peel Island, Bonin Islands (*P. A. Holst*).

Antennæ (except the basal joint) black. Thorax moderately narrowed in front, very slightly convex, distinctly but moderately finely punctured, the punctures slightly separated from each other on the disk, more crowded together and stronger at the sides; the disk has a punctiform impression on each side of the median line, rather in front of the middle; at the front margin there is on each side a small coppery spot, the commencement as it were of a longitudinal stripe. The elytra are a little wider than the thorax, much more gradually acuminate than is usual in this genus, closely and finely (but distinctly) punctured; each elytron has four well-marked smooth costæ, the third one abbreviated at the base and behind; the sutural angle is dentiform, but there is only a slight indication of serration at the apical margin. The sides of the sterna and abdomen are densely and very finely punctured and clothed with pale silvery-grey pubescence, which is only visible in certain lights.

This species is perhaps nearest to *C. purpureiventris*, Deyr., from Penang &c., but is much narrower, with the elytra more clearly quadricostate &c.

Ceresium simile, n. sp., Gahan.

Brunneo-ferrugineum, sparse griseo-pubescens; capite punctato; prothorace dorso dense rugoso-punctato, cum macula parva media lævi, supra sparse—lateribus et subtus sat dense—pubescente; scutello grisco; elytris denso punctatis, punctis postice gradatim decrescentibus, apicibus rotundatis; pedibus fulvo-testaceis, femoribus subabrupte clavatis; processu mestosterni fere plano; antennis corpore paullo longioribus, articulis a tertio ad decimum (quarto breviore excepto) subæqualibus.

Long. 13, lat. $3\frac{1}{2}$ mm.

This species bears a very close resemblance to *Ceresium unicolor*, Fabr.* But in the latter the disk of the prothorax is much less coarsely punctured, and the punctures are, in fresh specimens, almost concealed by the rather close pubescence which covers the whole of the prothorax. In the femora a more important difference may be noted; these, in the present species, are somewhat abruptly thickened, with a longer stalk at the base; in *C. unicolor* the femora are stouter, but the thickening is more gradual from the base.

In its structural characters the present species shows a close affinity to an undescribed form from China.

XXIV.—*Descriptions of three new Species of Butterflies from New Ireland, captured by the Rev. R. H. Rickard, in the Collection of H. Grose Smith.* By H. Grose Smith.

Asthipa clinias.

Allied to *citrina*, Feld., and *gloriola*, Butl., from which it differs in the following respects:—

Male.—On the upperside of anterior wings the vitreous spot between the second discoidal and upper median nervules is very short, the cell is almost entirely dark brown, there being only a comparatively short and narrow vitreous spot above the median nervure. On posterior wings the spot at the end of the cell is very small and there is a double submarginal row of white spots, the inner row being very distinct but interrupted between the lower median nervule and submedian nervure, the three upper spots being treble the size of those towards the anal angle; the outer row of spots is indistinct.

Underside. Anterior wings with a single row of submarginal white spots, outside which are two small spots near the apex and two between the upper and middle median nervules. On the posterior wings is a double row of submarginal white spots, the inner row interrupted as on the upperside, the outer

* In the Catalogue of Gemm. and Harold this species is erroneously placed in the genus *Hesperophanes*.

row being uninterrupted; on the lower median nervule, half-way between the margin and the median nervure, is a patch of white scales.

This species is much larger than either of those above mentioned.

Expanse of wings $3\frac{1}{2}$ inches.

Asthipa rotundata.

Male.—Upperside dark fuliginous brown, with bluish-white vitreous spots. Anterior wings with two spots beneath the first and second subcostal nervules; between these at the end of the cell are three elongate spots, the second the longest, the third the shortest; between the upper and second median nervules a cordate spot close to the median nervure and a small round spot beyond it; two broad elongate spots, somewhat attenuated externally, between the middle and lowest median nervules and between the latter and the submedian nervure respectively; a rather narrow elongate spot in the cell close above the median nervure. Posterior wings with the cell and the spots above and around it as in *citrina*, but those on the disk are narrower and that between the lowest median nervule and the submedian nervure is deeply bifid externally; there is a row of round white spots towards the outer margins of both wings, being on the anterior wings very conspicuous and on posterior wings nearly obsolete.

Underside. Both wings as above, but on the anterior wings near the outer margin between the median nervules are several minute white spots, and on the posterior wings are two very conspicuous, submarginal, uninterrupted rows of white spots, the inner row consisting of seven lunulate spots, the outer row of twelve small round spots.

The female resembles the male, but is paler, and the two spots below the cell are outwardly more acute.

Expanse of wings, ♂ $2\frac{3}{4}$, ♀ 3 inches.

Nearest to *A. garamantis*, Godman and Salvin; but the shape of the wings, especially in the male, is broader and rounder.

Doleschallia Rickardi.

Male.—Upperside. Both wings dark brown, rather paler towards the base. Anterior wings crossed beyond the cell by an oblique band of three rather broad blue spots, irrorated with white, extending from the costa to the upper median nervule; across the disk is a large blue patch, divided by the median nervules, extending at the upper end into the end of the cell and at the lower end as far as the submedian nervure, where it is narrower than at the top and slightly curves outwardly; a curved row of five subapical white spots.

Underside. Both wings dusky brown, paler towards the apex and outer margin of anterior wings and crossed by an irregular black line, which, on anterior wings, is narrowly margined externally from the costa to the upper median nervule by bluish white, thence internally to the middle of posterior wings by dusky white; outside the black line on both wings is a rather broad, ill-defined, darker brown band; on anterior wings three irregular bright brown lines cross the cell beyond the middle, the line nearest the base bordered externally and irregularly with bluish white; the five white subapical spots as above, beneath which are three nearly obsolete ocelli. Posterior wings beyond the middle with two conspicuous and several other nearly obsolete ocelli; a bluish-white spot in the cell on the median nervure edged externally with black.

Expanse of wings 2⅜ inches.

Nearest to *D. dascon* and *dasyclus*, Godman and Salvin.

XXV.—*Synoptical Revision of the Family* Halacaridæ. By Dr. E. L. Trouessart *.

The memoir in course of preparation, with the assistance of M. G. Neumann, upon the "Marine Acarina of the shores of France" being unavoidably retarded by the execution of the plates, we think it as well to give at present a synopsis of the actually known species of the family Halacaridæ. We hope in this way to induce the sending of new materials which will enable us to complete the investigation of this marine fauna which is still so little known.

The number of memoirs relating to the marine Acarina is still but small. We shall content ourselves with giving the following list † of the more important of them, referring

* Translated from the Bulletin Scientifique de la France et de la Belgique, tome xx. 1889, pp. 224–251.

† *Bibliography.*

1. Gosse, P. H. "On new and little-known Marine Animals" (Ann. Mag. Nat. Hist. ser. 2, vol. xvi. (1855) pp. 27 & 305, pls. 3 & 8).
2. Hodge, G. "Contributions to the Zoology of Seaham Harbour. I. On a new Marine Mite. II. On some undescribed Marine Acari" (Trans. Tyneside Nat. Field Club, 1860, vols. iv. & v.).

for a more complete bibliography to Dr. Lohmann's monograph indicated below.

In the following pages each bibliographic reference will be indicated by its number placed in parentheses, after the name of the author of the memoir cited.

Besides the species already known, we shall give the diagnoses of several new genera and species, derived not only from the French coasts, but also from other regions of the globe (Tierra del Fuego, New Zealand).

Family **Halacaridæ**, Murray, 1877.

Char. Exclusively marine Acarina, destitute of tracheæ, with a distinct rostrum; maxillary palpi free, fusiform, of 4 (rarely 3) joints, the first and third short, the second elongated, the fourth, or terminal, pointed and styliform. Mandibles terminated by a straight or recurved claw, which represents the immobile finger of the chelicera, the movable one being atrophied. Hypostome formed by a more or less elongate bivalve furrow, of which the two symmetrical parts are soldered together at the base or throughout their length. Three eyes, of which two are situated at the normal place upon the cephalothorax, and the third, unpaired one, in front upon the epistome. Integuments strengthened by more or less extensive dorsal and ventral dermal plates, with the surface smooth, grained, punctured, or sculptured. Legs lateral, well developed, terminated by a double claw, which is generally pectinate.

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3. Brady, G. S. "A review of the British Marine Mites, with descriptions of some new species" (Proc. Zool. Soc. 1875, p. 301, pl. 42).

4. ——. "Notes on British Freshwater Mites" (*ibid.* 1877, p. 24, pl. 4).

5. Murray, A. "Economic Entomology: Aptera, 1877," pp. 205 *et seqq.* (a summary of the preceding papers, with figures).

6. Chilton, C. "On two Marine Mites (Halacaridæ)" (Trans. New Zeal. Inst. vol. xv. 1883, with fig.).

7. Trouessart, E. "Note sur les Acariens marins recueillis par M. Giard au Laboratoire maritime de Wimereux" (Comptes Rendus, 5 Nov. 1888, p. 753; reproduced with some modifications in the Bull. Bibl. Scient. de l'Ouest, Niort, 1888, no. 8).

8. Lohmann, H. "Die Unterfamilie der Halacaridæ (Murray) und die Meeresmilben der Ostsee" (Zool. Jahrb. iv. 1889, p. 269, with 3 plates; issued as a separate paper in December 1888).

9. Trouessart, E. "Sur les Acariens marins des côtes de France, 2e Note" (Comptes Rendus, 3 June, 1889, p. 1178).

10. ——. "Diagnoses d'espèces et genres nouveaux d'Acariens marins des côtes de France" (Le Naturaliste, 11e année, 1889, pp. 162 & 181).

The absence of tracheæ and the form and arrangement of the palpi, the last joint of which is pointed and styliform (and not palpiform), suffice to distinguish this family from that of the Trombidiidæ, with which it has been proposed to unite the Halacaridæ. From its characters the latter family may be placed between the Gamasidæ and the Sarcoptidæ. At present we know about 7 genera and 35 species.

The Halacaridæ live in the sea and in the brackish water of estuaries and salt-marshes. They walk and climb, rather than swim, upon the bottom, the rocks, Algæ, and fixed or slow-moving animals of which they are *commensals*. Their food seems to be varied; it consists in great part of Diatomeæ and of organic matters in course of decomposition derived from the fragments rejected by the animals of larger size upon which we find them, and which belong to all classes—Crustacea, Mollusca (oysters, mussels, &c.), Echinoderms, Acalephæ, Hydroids, Corals, Bryozoans, Sponges, &c. The young of many species may be regarded as *parasites*, feeding almost exclusively upon organic matters, especially the ova of Copepoda, and attaching themselves to other animals to profit by what falls from their table. The adults on the contrary lead a vagabond life, and seek in preference the Diatoms which they find in abundance attached to the fronds of Algæ.

We find the Halacaridæ from the zone of stranded Algæ to a depth of 30–50 fathoms; but it is in the *Laminarian zone*, or more exactly in the *zone of the Corallines and Red Algæ*, that they are most abundant, at depths of 5–10 fathoms. Very few are found upon the brown Algæ (Fucaceæ); on the other hand they are numerous and varied specifically upon the red and calcareous Algæ (Florideæ and Corallinæ). Upon the great rocky bottoms destitute of vegetation we meet with types (*Scaptognathus*, *Coloboceras*) which are wanting everywhere else. Their geographical distribution, although in general pretty extensive, presents some remarkable peculiarities; thus, the genus *Agaue*, an essentially southern type, widely diffused in the Mediterranean and extending to the southern hemisphere (Tierra del Fuego), does not appear to advance in the ocean to the north of the mouth of the Loire, and is wanting in the North Sea and the Baltic.

The distinction of the species in this group presents great difficulties in consequence of the great uniformity of the type, of variations of colour due to the kind of food, and of this peculiar fact, which it is important to mention, that the *nymphs*, before their last moult, *already present a rudiment of* *the genital organ* (H. Lohmann). The legs are generally shorter in the nymphs, which have in each limb *one joint less* * than the adults. Otherwise the construction of the rostrum, tarsi, and dermal plates is very nearly the same as in the adult.

Many individuals at the moment of their capture have the body and limbs incrusted with a sort of mud, in the midst of which Acinetæ are sometimes fixed in considerable numbers.

Synopsis of the Genera aud Species of the Family Halacaridæ.

Genus RHOMBOGNATHUS, Trt. 1888.

Trouessart (7), November 1888, p. 754.
Aletes, Lohmann (8), December 1888, p. 51.
Pachygnathus, pt., Gosse (1), 1855.

Char. Rostrum short, conical, with the maxillary palpi lateral, applied closely along the mandibles, which are terminated by a hooked claw. Tarsus separated from the double terminal claw by an additional cylindrical, slender, and more or less elongated joint.

Seven species, of which four occur on the French coasts. Most of them are of a greenish-black colour, of small size, and of a short, thickset form.

1. *Rhombognathus pascens.*

Ateles pascens, Lohm. (8), p. 64, figs. 64, 70.

Char. Claws angularly recurved; additional piece of the tarsus produced in the form of a hook *only in the anterior feet.* Coxæ of the first pair of legs united into a single ventral plate. Ocular plates with only a single cornea. Total length 0·35 millim.

Hab. Atlantic coasts, France: Baie de Port-lin, near Le Croisic, upon stranded red Algæ (*E. Chevreux*), rather rare. Shore of the Channel, Etretat (*Mlle. C. Trouessart*). Baltic, Kiel (*Lohmann*), upon sandy shores, living and stranded red Algæ.

2. *Rhombognathus Seahami.*

Pachygnathus Seahami, Hodge (2), 1860.
Aletes Seahami, Lohm. (8) p. 57, figs. 88, 94.

Char. Claws angularly recurved; additional piece of the

* *Four*, instead of *five* as in the adult.

tarsus *hooked in all the feet.* Coxæ of the first pair united into a single ventral plate. *Claws with a simple comb.* Ocular plates having only a single cornea. Total length 0·37 millim.

Hab. Atlantic coasts: France, Le Croisic, Pen-bronn and Port-lin (*Chevreux*), upon Corallines, brown Algæ, and stranded Algæ. Very common everywhere; the most widely distributed species of the coast of Le Croisic. Shores of the North Sea; England, Seaham Harbour, littoral zone. Shores of the Baltic, Kiel (*Lohmann*), region of Red Seaweeds.

3. *Rhombognathus setosus.*

Aletes setosus, Lohm. (8), p. 58, figs. 79, 80.

Char. Claws recurved *like sickles*; additional joint of the tarsi *with no hook*; anterior margin of the epistomial plate in the form of a *hood entirely concealing the rostrum.* Coxæ of first pair well separated, forming a narrow chitinous band on each side. Ocular plates with the cornea simple. Total length 0·32 millim.

Hab. Shores of the Baltic, Kiel (*Lohmann*); sandy shores.

4. *Rhombognathus nigrescens.*

Pachygnathus nigrescens, Brady (4), p. 26, pl. iv. figs. 4, 5.
Aletes nigrescens, Lohm. (8), p. 60.

Char. Claws angularly recurved and furnished *with a double comb*, without lateral teeth; additional joint of tarsi furnished with a hook on all (?) the feet. Ocular plate with the cornea simple. Size very large, double that of the other species. Total length 0·72 millim.

Hab. A single specimen found in England by Brady in a pool of fresh water on the rocks (Northumberland).

5. *Rhombognathus notops.*

Pachygnathus notops, Gosse (1), p. 305, pl. viii. figs. 1–4.
Aletes notops, Lohm. (8), p. 62, figs. 89, 94.

Char. Claws recurved *like sickles*, with a lateral tooth, but without a comb; additional joint of tarsi without a hook; *epistomial plate leaving the rostrum exposed*; ocular plates furnished *with a double cornea.* A plumose hair on the tarsi of the first pair of feet. Total length 0·35 millim.

Hab. Shores of the Ocean. France: Le Croisic, Pen-bronn (*Chevreux*), on Corallines (*Corallina officinalis*) and green Algæ, pretty common. British coasts: Shetland

Islands, Ilfracombe (*Gosse*), littoral zone. Baltic, Kiel (*Lohmann*), region of Red Seaweeds.

6. *Rhombognathus magnirostris.*

Trouessart (10), Le Naturaliste, August 1889, p. 181.

Char. Like *R. notops*, but larger and stouter; additional joint of the feet much elongated, not hooked. Rostrum large and broad. Epistome cut off squarely at the level of the base of the palpi. Legs with long and slender setæ. Two plumose hairs well developed on the third joint of the *four pairs of feet.* Comb of the accessory tooth of the claws broad and strong. Total length 0·45 millim.

Hab. Shores of the Mediterranean, upon the Corsican Moss (*Gigartina helminthocorton*) and the Corallines and Red Seaweeds collected in the same localities and confounded under that name.

R. magnirostris, var. *plumifer*, var. nov.

Differs from the type by the presence of *a third feebly plumose hair* on the third joint of all the legs. The *other two strongly plumose.* Total length 0·38 millim.

Hab. Shores of Tierra del Fuego: Saddle Island (Cape Horn), upon Seaweeds (*Codium fragile, Ceramium Dozii*), collected by M. Hariot (Mission du Cap Horn).

7. *Rhombognathus minutus.*

Pachygnathus minutus, Hodge (2), 1860.
Aletes minutus, Lohm. (8), p. 65.

Char. Claws falciform, pectinated, with a lateral tooth; additional joint of tarsus hooked. Ocular plates with a double cornea. Size small? (species imperfectly known). Total length 0·28 millim.

Hab. English coast: Seaham, Northumberland (*Hodge*); littoral zone.

Genus Simognathus, Trt., 1889.

Trouessart (9), p. 1179, & (10), p. 162.
Pachygnathus, pt., Brady (3), p. 306.

Char. Rostrum short and broad, with *maxillary palpi touching each other above, applied to one another in the median* *line*, passing beyond the mandibles and the hypostome, their extremities being directed downwards (and not inwards, as in *Rhombognathus*). No additional joint in the tarsus; legs of six joints.

By the arrangement of the parts of the mouth, this genus approaches *Leptognathus* rather than *Rhombognathus*. It may be regarded as a *Leptognathus* with a much shortened rostrum. A single known species.

1. *Simognathus sculptus.*

Pachygnathus sculptus, Brady (3), p. 306, pl. 42. figs. 1–6.
Simognathus sculptus, Trouessart (9), p. 1179, & (10), p. 162.

Char. Legs nodose, with angular joints, especially the penultimate joint of the anterior pair, which is armed with a strong spine at its posterior and inferior angles. Claws not pectinated; those of the anterior feet stronger and less recurved than those of the other feet. All the plates of the cuirass (except the sternal and ventral plates) strongly pitted, as also the hypostome and the first three joints of the legs. Total length 0·42 millim.

Hab. This fine species appears to occur only upon rocky bottoms, at depths varying from 10 to 50 metres. Shores of France: Rochers de Basse Kikerie (near Le Croisic), dredging by means of swabs (*Chevreux*), a single individual. English coast: Durham and N. Yorkshire, Robin Hood's Bay (*Brady*), at 35 fathoms.

Genus Coloboceras, gen. nov.

Char. Rostrum cylindro-conical, *with lateral palpi parallel to the sides of the rostrum*, formed of *three joints*—the first short, the second three times as long; the third rather short, conical, terminated by a small point. Mandibles styliform, terminating in two long setæ. Legs of five joints.

This new genus approaches *Halacarus* more than any other genus, and may be regarded as forming the passage between *Rhombognathus* and *Halacarus*. It differs essentially from the latter by its palpi, which have only three joints, the third and fourth appearing to be soldered into one. Only one species known.

1. *Coloboceras longiusculus*, sp. n.

Char. Body elongate, of a garnet-red colour, nearly black; the legs of a lighter red, much shorter than the body, slightly nodose, with the claws terminated by two teeth, the larger of which is inserted nearly at a right angle; destitute of a ciliated comb. Rostrum small, with the epistome cut squarely at the base of the palpi, the hypostome prolonged into a bivalve spatuliform furrow, within which the mandibles slide, each terminating in a long seta, which passes beyond the rostrum. Anus terminal. Total length 0·50 millim.

Hab. Shores of France: Roches de Castouillet (near Le Croisic), by dredging with the aid of swabs (*Chevreux*); two individuals.

Genus HALACARUS, Gosse, 1855.

Halacarus, Gosse (1), p. 27.
Halacarus, *Copidognathus*, and *Leptopsalis*, Trouessart (7), p. 753.

Char. Rostrum elongated, cylindro-conical; palpi free, parallel, articulated upon the sides of the rostrum, composed of four joints, of which the third is much shorter than the terminal joint, which is strongly conical, elongated, often styliform, and furnished with three divergent setæ upon its inner margin; second joint the longest of all. Hypostome in the form of a more or less elongated bivalve furrow, triangular or truncated in front. Mandibles (cheliceræ) terminated by a single finger, generally hooked. Claws of the feet inserted directly upon the tarsus without any additional joint.

The number of species of this genus is already considerable, at least seventeen, eleven of which occur upon the French coasts. This is the reason that we attempted to subdivide it by forming the genera *Copidognathus* and *Leptopsalis*, the former founded upon a species (*C. glyptoderma*) in which the mandibles are very strong, and terminate in *a straight, knife-shaped finger with a serrated blade.* But a thorough examination of several allied species having shown this character to be rather variable, we have preferred to reunite this species with the genus *Halacarus* proper. The genus *Leptopsalis* includes two species in which *the last joint of the palpi is bifid, simulating a little forceps*; this character seems to be of sufficient importance for us to retain this group as a subgenus.

Subgenus HALACARUS, proper.

Char. Last joint of the palpi terminating in a single point.

In the enumeration of the species we shall follow the order and arrangement adopted by M. Lohmann in his Monograph (8).

Group A *a.*—Rostrum small, triangular, conical, with rather short palpi, *the last joint conical at its point only, and very little longer than the penultimate.* A single exotic species, which, by the shortness of its palpi, approaches the genus *Coloboceras.*

1. *Halacarus parvirostris*, sp. n.

Char. Rostrum presenting the characters of the group; palpi with the last joint cylindrical for four fifths of its length, and terminating suddenly in a very small point. Hypostome groove-like, constricted in front, truncated at the level of the base of the last joint of the palpi. Epistome presenting an obtuse, rounded projection at the level of the base of the rostrum. Anterior legs shorter and more robust than the posterior, with the second joint inflated, and the fourth nearly triangular, furnished with a spine beneath; claws with no ciliated comb; no ungueal groove on the tarsus. Dermal plates finely punctured in indistinct rosettes. Total length 0·40 millim.

Hab. On seaweeds from New Zealand sent to the Museum at Paris (*M. Hariot*). This species is, in all respects, very distinct from the two species described by Chilton, which will be mentioned further on.

Group A.—Rostrum narrow, with the lateral margins parallel as far as the basal region; hypostome compressed, longer than the basal part of the rostrum; third joint of the palpi bearing at its antero-internal angle a very fine spine directed obliquely forward; fourth joint sabre-shaped. Sexual aperture projecting in the form of a bivalved bulb. Two species.

2. *Halacarus Murrayi.*

Lohmann (8), p. 70, figs. 83, 86.

Char. Those of the group; anus terminal. Legs slender, the posterior very long; claws much elongated, pectinate; no ungueal groove on the tarsi. Dermal plates feebly developed. Ocular plates with a single cornea, and in the inner angle a large pore* with a small chitinous plate behind it. *All the hairs of the legs very long and very slender, not spinous.* Total length 0·52–0·57 millim.

Hab. Baltic, Kiel (*Lohmann*), in the region of Red Sea-

* To see these details of the chitinous cuirass of the Halacaridæ it is indispensable to treat them with a more or less concentrated solution of potash, which renders them colourless and transparent.

weeds on the Florideæ, sponges, and *Flustræ*, at a depth of about 12 fathoms.

3. *Halacarus levipes.*

Trouessart (10), Le Naturaliste, p. 162.

Char. Very similar to the preceding species, but differing from it in the presence of *spinous hairs*, mixed with the long slender hairs, *upon the anterior legs.* Hypostome less compressed, elongate triangular. It is perhaps only a southern variety of *H. Murrayi.* Total length 0·50 millim.

Hab. Shores of the Mediterranean. A single individual found upon Corsican moss (*Gigartina helminthocorton*).

GROUP B.—Rostrum triangularly conical, with the apex directed forward; hypostome shorter than the basal part of the rostrum, with no constriction at its base. Last joint of palpi conical, more or less pointed, but not styliform. Genital aperture in the form of an oval frame, differing but little in the two sexes.

Subgroup 1.—Body compressed, abdomen elongated as in the preceding group, flanks parallel to the level of the insertion of the legs.

4. *Halacarus floridearum.*

Lohmann (8), p. 72, figs. 111, 115.

Char. Anus terminal; third joint of palpi furnished on its inner margin with a thick, non-setiform spine. *Ocular plates with no cornea*; third joint of first pair of legs bearing only three hairs planted in a triangle upon the most inflated part. *Claws ciliated. Dermal plates pitted except the sternal plates.* Total length 0·45–0·50 millim.

Hab. Baltic, Kiel (*Lohmann*), region of Red Seaweeds, on Florideæ, at depths of 3–12 fathoms.

5. *Halacarus balticus.*

Lohmann (8), p. 73, figs. 103, 120.

Char. Anus terminal; third joint of palpi furnished with a strong spine upon its inner margin; third joint of first pair of legs having *two dorsal setæ* behind the triangle formed by the three hairs inserted about the middle. Ocular plates with a large cornea. Epistomial plate with a nearly straight anterior margin. *Claws not ciliated.* Tarsi with a slightly developed ungueal groove. *Dermal plates pitted only on the back.* Total length 0·60–0·65 millim.

Hab. French coast: Pas de Calais, at Wimereux (*Giard*), upon *Eudendrium capillare*; Le Croisic (*Chevreux*), upon Bryozoa (*Alcyonidium hirsutum*), and Baie de Port-lin upon *Facus serratus*. Baltic: Kiel (*Lohmann*), region of Red Algæ, at 12 fathoms.

6. *Halacarus striatus.*

Lohmann (8), p. 74, fig. 117.
H. inermis, Trouessart (7), p. 754.

Char. Anus terminal. *No spine on the third joint of the palpi.* Ocular plates narrow, without cornea. Dermal plates pitted only on the back. Claws pectinate. No ungueal groove on the tarsi. Total length 0·62–0·70 millim.

Hab. French coasts: Le Croisic (*Chevreux*), Laminarian zone, upon Corallines; Baie de Port-lin and open coast upon *Corallina officinalis*. North Sea, upon *Thuiaria Thuia*, off Newcastle-on-Tyne (*Giard*). Baltic: Kiel (*Lohmann*), region of Red Algæ, at 3–5 fathoms.

Subgroup 2.—Abdomen short, with a semicircular outline posteriorly; flanks swelled, convex, and not parallel.

7. *Halacarus spinifer.*

H. ctenopus, pt., Trouessart (7), p. 754.
H. globosus, Trouessart, MS., *loc. cit.*
H. spinifer, Lohmann (8), p. 75, figs. 101, 102.

Char. Palpi with the third joint furnished with a strong spine on its inner margin; third joint of first pair of legs armed with two spines behind the triangle formed by the dorsal setæ. Claws of the first pair very short and very stout; *all the claws pectinate.* Ocular plates with corneæ. Epistomial plate produced into a point above the rostrum. Anus terminal.

The adults are generally of a dark colour (brown, more or less blackish); the young and the nymphs are light-coloured, yellowish, or of a more or less lively coral-red. It is the largest species known in the family, and one of the commonest on our shores. Total length 1·00–1·10 millim.

Hab. French coasts: Pas de Calais, Wimereux (*Giard*), upon the byssus of mussels, on *Lasæa rubra* and *Eudendrium capillare*; canal from Caen to the sea (*Le Sènèchal*) in brackish water, on Hydroids; Atlantic coast; Le Croisic (*Chev-

reux) upon Algæ (Corallines &c.), very common. Baltic: Kiel and Gotland (*Lohmann*) upon Red Seaweeds (at 12 fathoms) and on Green Seaweeds.

8. *Halacarus ctenopus.*

H. ctenopus, Gosse (1), p. 28, pl. iii. figs. 6–10; Brady (3), p. 310; Lohmann (8), p. 77.

Char. Like the preceding species, but smaller and more elongated, and never presenting the dark colour of the adult *H. spinifer.* Epistome with an acute anterior point. Claws of the first pair very similar to those of the others. *Claws of the third and fourth pairs destitute of ciliated combs*, while those of the other two pairs (2 and 3) are provided with them. Anus terminal. *A notogastric plate.* Ungueal groove but slightly developed, as in the preceding species. Total length 0·80 millim.

Hab. French coasts (rare): Le Croisic (*Chevreux*), on floating seaweeds. Coasts of England and Ireland, the Shetland islands, Scilly, &c. (*Gosse, Brady*), at depths varying, according to the localities, from 7 to 35 fathoms (littoral, Laminarian and Coralline zones).

9. *Halacarus actenos*, sp. n.*

Char. Very like the preceding species, *but all the claws destitute of ciliated combs. No notogastric plate.* Epistomial plate terminating *behind* in a triangle. *No ungueal groove* on the tarsi. Total length from 0·65 millim. (male) to 0·75 millim. (female).

Hab. French coasts (Atlantic), scarcer than *H. spiniger*, but more generally distributed than *H. ctenopus*: Le Croisic (*Chevreux*), Baie de Port-lin, on *Fucus serratus*; Arcachon, on oysters (*Trouessart*); Saint Jean-de-Luz (*Neumann*), on Algæ (a male individual more brightly coloured (orange-red) and with shorter limbs than the males from Le Croisic).

10. *Halacarus Harioti*, sp. n.

Char. Epistomial plate forming *a very obtuse angle in*

* This species may perhaps be the *Halacarus ctenopus*? of Grube (*H. frontispinis* in the text), found by that naturalist at Roscoff (Abhandl. schles. Ges. Naturw. 1868, pp. 123, 124) and described as resembling *H. ctenopus*, but with non-pectinate claws. However, Grube says formally that he did not see, on the penultimate joint of the palpi, the short and strong spine which characterizes *H. actenos* as well as *H. ctenopus*.

front. All the claws pectinate, those of first pair like the others; a well-developed *ungueal groove* on the tarsi. Mandibles slender, with a feeble claw. A well-developed notogastric plate. In other respects like the preceding species. Total length 0·70 millim.

This species is dedicated to M. Hariot, the botanist attached to the "Mission du Cap Horn," who collected it at the same time as the Algæ of that region.

Hab. Shores of Saddle Island, Cape Horn (*Hariot*), upon Algæ (*Codium fragile*).

Subgroup 3.—Form of the rostrum and palpi as in the preceding subgroup, but the third joint of the palpi without the internal spine. Plates of the cuirass greatly developed and strongly sculptured as in the following subgroup. Sculpture of the notogastric plate forming longitudinal lines. Epistomial plate cut square in front, leaving the rostrum exposed.

11. *Halacarus Fabricii.*

Lohmann (8), p. 79, figs. 81, 82.

Char. Ocular plates wide, furnished with a very visible cornea. Median spine of the penultimate joint of the first and second pairs of legs finely pennate and furnished with a tubercle at the base. Epistomial plate rounded in front. All the claws pectinate; tarsus with a slightly developed ungueal groove. Anus terminal. Total length 0·52 millim.

Hab. French coast: Arcachon (*Trouessart*), on oysters; shores of the Mediterranean (*Trouessart*), on Corsican moss. Baltic: Kiel (*Lohmann*), on fixed and floating Green Algæ and on Red Algæ (at 12 fathoms).

12. *Halacarus loricatus.*

Lohmann (8), p. 81.

Char. Ocular plates wide, with the cornea apparent. *Spine of the penultimate joint not pennate* and without a tubercle at the base. Otherwise like the preceding species. Total length 0·40 millim.

Hab. Baltic: Kiel (*Lohmann*), upon Red Algæ at 12 fathoms.

13. *Halacarus glyptoderma.*

Copidognathus glyptoderma, Trouessart (7), p. 754.

Char. Like the preceding species, *but the hypostome square, truncated, wider and shorter than that of* H. loricatus. Mandibles stout, terminated by *a straight nail in the form of a serrated knife-blade.* Spine of anterior feet not pennate. Epistomial plate much developed, with three impressions sculptured in relief, one on each side and one in front. Total length 0·50 millim.

Hab. Atlantic coast of France: Marennes (Charente-Inférieure), upon oysters (*Trouessart*).

14. *Halacarus Lohmanni*, sp. n.

Char. Like the preceding, especially *H. Fabricii. Anterior legs stouter and shorter than the posterior*, with the *margins of the joints angular beneath*; tarsus with a well-developed ungueal groove. Total length 0·40 millim.

This species is dedicated to Dr. H. Lohmann, author of the monograph of the Halacaridæ of the Baltic.

Hab. Shores of New Zealand; upon Algæ sent to the Paris Museum (*Hariot*).

Group C.—Rostrum with the base wide and constricted; the hypostome short, forming with the rostrum a reversed heart; cuirass complete, the strongly sculptured plates only leaving between them a linear space. Last joint of the palpi slender, elongate, styliform.

15. *Halacarus rhodostigma.*

Gosse (1), p. 27, pl. iii. figs. 1–5; Lohmann (8), p. 83.

Char. Claws of the feet destitute of lateral teeth and ciliated combs. Tarsi with no ungueal groove. Cuirass complete, covered with points in rosette *not forming more salient patterns or longitudinal streaks. Second joint of the anterior legs inflated.* Total length 0·35–0·40 millim.

Hab. French coast: Arcachon, Marennes (*Trouessart*), upon oysters (common). English coasts: North Sea (Northumberland), Channel (Weymouth, *Gosse*); littoral zone of Laminariæ and Corallines.

16. *Halacarus gracilipes*, sp. n.

Char. Claws destitute of lateral teeth and of combs as in the preceding species. No ungueal groove on the tarsus. Cuirass complete, *with a sculpture forming projections and longitudinal lines, finer upon the epistomial and notogastric plates.* Second joint of the anterior limbs not more inflated than that of the other legs, which are all slender with cylindrical joints. Total length 0·40–0·45 millim.

Hab. French coasts: Le Croisic (*Chevreux*), upon *Lasœa rubra*; Roches de Castouillet, by dredging with swabs; Mediterranean (*Trouessart*), upon Corsican moss (*Gigartina helminthocorton*). English coast: Scilly Islands (in a preparation communicated by Mr. Brady, mixed up with *Halacarus ctenopus*).

17. *Halacarus oculatus.*

Hodge (2); Lohmann (8), p. 82, figs. 67, 68.

Char. Like the two preceding, but rather more elongated; *second joint of anterior limbs inflated. Claws furnished with a lateral tooth and a ciliated comb.* Cuirass with a sculpture forming projections and lines as in the preceding species. Total length 0·38–0·42 millim.

Hab. French coast: Arcachon (*Trouessart*), upon oysters. English coast: North Sea, Seaham (*Hodge*). Baltic, Kiel (*Lohmann*); region of Red Algæ and of floating seaweeds.

18. *Halacarus gibbus*, sp. n.

Char. Legs *very nodose*, having the second and fourth joints inflated on the four pairs, but especially on the anterior pairs; *claws not pectinate*, but furnished with a small slender tooth. Epistomial plate presenting in the middle *a strong oblique pyramidal crest*, the point of which is confounded with the anterior point of the plate, thus *forming a sort of boss or hood which projects in an acute angle above the rostrum.* Cuirass presenting projections and lines with distinct punctuation, as in the preceding species. Total length 0·40–0·45 millim.

Hab. French coast: Le Croisic (*Chevreux*), Roches de Castouillet, by dredging with swabs.

Subgenus Leptopsalis, Trt., 1888.

Genus *Leptopsalis*, Trouessart (7), p. 754.

Char. Rostrum elongated, with the palpi slender, parallel, *the last joint terminated by a double point; hypostome forming a narrow spatuliform groove, attaining the base of the last joint of the palpi.* Otherwise the characters of the genus *Halacarus* proper.

Two or three species. The type is *Leptopsalis Chevreuxi*, Trt.

19. *Halacarus* (*Leptopsalis*) *longipes.*

Trouessart (7), p. 754.

Char. Facies of the nymphs of *Hal. spinifer*, but presenting the characters of the subgenus. A small spine directed obliquely forward upon the inner margin of the penultimate joint of the palpi. Epistome cut squarely in front. Legs long, cylindrical; claws pectinate, with a very feeble lateral tooth; no ungueal groove. Anterior legs with slender setæ, sparingly spinous. Anus terminal. Total length 0·60 millim.

Hab. French coast: Pas-de-Calais, Wimereux (*Giard*), on the byssus of mussels. A single individual, 2nd nymph *.

20. *Halacarus* (*Leptopsalis*) *Chevreuxi.*

Trouessart (10), p. 162.

Char. Body ovoid-conical, with the anus terminal. *Legs very nodose, with the penultimate joint pyriform.* Epistome short, *bilobate*, with a median emargination. Rostrum much elongated, slender, and compressed; *hypostome very long, thin, and spatuliform*; mandibles very slender, nearly styliform. Claws pectinate, with a small median piece. Tarsus with an ungueal groove. The variety from the Mediterranean has the penultimate joint of the legs rather angular than pyriform. The cuirass is nearly smooth. Total length 0·80–0·90 millim.

Hab. French coast: Le Croisic (collected in numbers by M. Chevreux, to whom the species is dedicated), Baie de Port-lin on Red Seaweeds (Florideæ), on *Polysiphonia* and on *Alcyonidium hirsutum*; Baie de Croisic on *Corallina officinalis*, Laminarian zone; Banc de Basse-Hergo on brown Algæ, &c.; Saint-Jean-de-Luz (*Neumann*) on Algæ. Shores of the Mediterranean (*Trouessart*) on the Corsican moss (*Gigartina helminthocorton*) †.

* Another Halacarid, taken by M. Chevreux at Le Croisic upon Sponges (*Halichondria panicea*), greatly resembles this species and has the extremity of the palpi bifid; but the hypostome is less spatuliform, the hairs of the anterior legs are spinous, as in *H. spinifer*, and there is an ungueal groove.

† A third species would appear to take its place in this subgenus, viz.:—*Halacarus olivaceus*, Grube, Abhandl. schl. Ges. Naturw. 1868, p. 121, pl. ii. fig. 3. This species, which we know only from Grube's figure and description, approaches *Leptopsalis Chevreuxi* in the form of its rostrum and legs. Obtained by Grube at the island of Batz, near Roscoff.

Genus Agaue, Lohmann, 1889.

Lohmann (8), p. 85.

Char. Palpi articulated laterally to the rostrum, elongated, mobile, *third joint scarcely shorter than the last one*, which is conical and bears some short setæ. Otherwise the characters are those of *Halacarus* proper.

M. Lohmann (*l. c.*) has taken as the type of this genus the *Halacarus parvus* of Chilton *, a species from New Zealand which is known to us only from the description and figure given by the last-named author.

But this description and figure leave some doubts as to the true affinities of this species, which might well be a *Leptopsalis.* In consequence of this M. Lohmann (*in litteris*) has kindly agreed with us to take as the type of the genus *Agaue brevipalpus*, Trt., a species from the Atlantic and Mediterranean, which distinctly presents the characters of the genus as indicated by M. Lohmann himself.

This genus, which is essentially southern (as it does not advance towards the north beyond the mouth of the Loire), includes, besides *H. parvus*, four species, of which three are European.

1. *Agaue brevipalpus.*

Trouessart (10), p. 181.

Char. Rostrum elongated, with a broad conical base, and with the anterior region (starting from the base of the palpi) narrow and compressed; *hypostome passing beyond the point of the palpi*; third joint of the palpi bearing a short and slender spine directed forward. Epistome terminated in front by a *very obtuse point.* Anterior legs more robust than the

* Chilton, *l. c.* (6), describes two species of Halacaridæ from the shores of New Zealand, viz.:—

1. *Halacarus parvus*, Chilton.

Agaue parva, Lohmann, *l. c.* p. 86.

Char. Epistomial plate cut squarely, slightly rounded in front. Claws pectinate, furnished with a large lateral tooth; an ungueal groove. First pair of legs with close-set tactile hairs. Total length 0·70 millim.

Hab. New Zealand, Littleton Harbour, littoral zone.

2. *Halacarus truncipes*, Chilton.

Char. This species is remarkable for the great development of the ungueal groove of the tarsus, within which the claws can be withdrawn and completely concealed, in such a way that Chilton supposes that they do not exist and are replaced by simple hairs.

Same habitat.

others, bearing large prickles with blunt or turned points. *Claws not pectinate, with no median piece.* Tarsi with no ungueal groove. Anus terminal. Dorsal plates not well-developed, separated by a *wide space of striated and shagreened skin.* Total length 0·53 millim.

Hab. French coast: Arcachon (*Trouessart*) on oysters, Le Croisic (*Chevreux*) on Red Seaweeds (Florideæ), Baie de Port-lin. Mediterranean (*Trouessart*) on the Corsican moss (*Gigartina helminthocorton*).

2. *Agaue hirsuta.*

Trouessart (10), p. 181.

Char. Like the preceding species, but larger and more robust. *Legs of the first pair very long and very stout, twice as thick as the others*, with very stout blunted prickles. *Epistome acutely pointed.* Rostrum short and stout, *with the hypostome shorter than the palpi*, deeply bilobed. Claws of the mandibles recurved and very stout. Last joint of the palpi short, acutely pointed; third joint *furnished with a stout short spine*, directed inwards or somewhat oblique. Claws briefly pectinate in a serrate form, *furnished with a very stout unidentate median piece.* Two rows of stout setæ on the back. Total length 0·70–0·75 millim.

Hab. Shores of the Mediterranean on the Corsican moss (*Trouessart*).

3. *Agaue microrhyncha.*

Trouessart (10), p. 181.

Char. Like the two preceding in general form, *but with a short, small, and feeble rostrum.* Epistome obtuse. Claws pectinate, except those of the first pair, with no projection at the median piece. *Dermal cuirass complete*, the dorsal plates having only a nearly linear space between them. Total length 0·43 millim.

Hab. Shores of the Mediterranean on the Corsican moss, with the two preceding species (*Trouessart*).

4. *Agaue cryptorhyncha*, sp. n.

Char. Similar to *A. hirsuta*, but with the *anterior legs scarcely longer* and a little stouter than the others, second and fourth joints armed with large blunt prickles. Two stout pointed prickles below the penultimate (4th) joint of the second pair of legs. *Rostrum in great part concealed beneath the* *epistome*, of which the *anterior margin*, *cut squarely* and a little rounded, advances as far as half the length of the second joint of the palpi. Inward spine of third joint very slender. *Claws pectinate* except the first pair; tooth of the median piece appearing to be inserted *beneath the tarsus* in the form of a short spine (except in the first pair, where it is in its normal position, as in *A. hirsuta*). Plates of the cuirass finely punctured, leaving little space between them. Total length 0·68 millim.

Hab. Shores of Tierra del Fuego, Cape Horn (*Hariot*), upon Algæ (*Ceramium Dozii*).

Genus Scaptognathus, gen. nov.

Char. Rostrum large, separated from the body by a well-marked constriction, pyriform as in the genus *Leptognathus*. Palpi very stout, *arranged laterally*, *widely separated from each other, and constructed to act horizontally one opposite to the other*; second joint very long and very stout, armed at its extremity with a strong double spine directed inwards; third joint null or very small; fourth bent downwards, very slender, styliform. Epistome very short or null, leaving the rostrum exposed. Hypostome very long, attaining the extremity of the second joint of the palpi, strongly spatuliform. Mandibles very long and very slender, with the point straight styliform.

Only one species known. Notwithstanding the resemblance presented by this type in the general form of the rostrum to the genus *Leptognathus*, it differs therefrom essentially in the structure of the parts of the mouth. The palpi, with the second joint very robust and furnished with an inwardly-directed fork at its extremity, constitute organs of prehension evidently intended to act in the horizontal and not vertical direction. On the other hand the very slender mandibles can act only in an antero-posterior direction by sliding in the groove of the hypostome.

1. *Scaptognathus tridens*, sp. n.

Char. Rostrum very large, nearly as long as the body; second joint of the palpi in the form of a cubitus, of which the olecranon would represent the anterior extremity outwards; this extremity furnished within *with a strong forked spine in the form of a mattock*, forming, with the slender and pointed last joint, which is bent downwards, a sort of trident. Hypostome transparent, dilated in front in the form of a T. Legs all slender, cylindrical, with feeble, non-pectinate claws. Cuirass sculptured like the skin of a Crocodile, especially on the base of the rostrum. Total length 0·75 millim. (rostrum alone 0·30 millim.).

Hab. Le Croisic (*Chevreux*), Roches de Castouillet, by dredging with swabs.

Genus Leptognathus, Hodge, 1860.

Leptognathus, Hodge (2); Lohmann (8), p. 86.

Char. Rostrum very long, compressed, constricted at the base. Palpi articulated upon the dorsal surface of the rostrum, along the median line, forming, with the elongated pointed hypostome, a forceps, of which the movable branches (palpi) move vertically; the second joints of the palpi touching each other throughout their length in repose. Claw of the mandible recurved. Epistome very short, apparently replaced by the base of the maxillary palpi. Three species of this genus have been described.

1. *Leptognathus falcatus.*

Leptognathus falcatus, Hodge (2).
Rhaphignathus falcatus, Brady (3), p. 307, pl. xlii. figs. 7–10.
Leptognathus falcatus, Lohmann (8), p. 89.

Char. Epistome extending as far as the base of the palpi, between which it projects in the form of a small button. Anus projecting in a bulb-like form. *Plates of the cuirass smooth.* Total length 0·90 millim.

Hab. French coast: Pas-de-Calais, Wimereux (*Giard*), on *Lasæa rubra* and *Corallina officinalis.* English coast (*Hodge, Brady*): Laminarian and Coralline zones, Northumberland and Scilly Islands.

2. *Leptognathus marinus.*

Lohmann (8), p. 88, figs. 121, 122.

Char. Differs from the preceding species chiefly by its small size. Total length 0·60 millim.

Hab. French coast: Le Croisic (*Chevreux*), Grande Côte, on *Corallina officinalis.* Baltic: Kiel (*Lohmann*), upon red and green Algæ, at 12 fathoms.

3. *Leptognathus violaceus.*

Kramer, Arch. f. Naturg. 1879.

Char. This species appears to differ from the preceding only by its *pitted cuirass.* Total length 0·88 millim.

Hab. Pools of Thuringia, upon Algæ (*Kramer*).

Synoptical Table of the Genera of the Family Halacaridæ.

A. Rostrum short, triangular; four joints in the palpi, which are short, convergent.	Palpi lateral, separate			1. RHOMBOGNATHUS, Trt.
	Palpi touching above the rostrum........................			2. SIMOGNATHUS, Trt.
B. Rostrum elongate, not constricted at its base, with the palpi parallel.	Only three joints in the palpi			3. COLOBOCERUS, Trt.
	Four joints in the palpi.	Joint 3 of palpi much shorter than joint 4.	Palpi terminated by a simple point.	4. HALACARUS, Gosse.
			Palpi terminated by a double point.	Subg. LEPTOPSALIS, Trt.
		Joint 3 of palpi nearly as long as joint 4.		5. AGAUE, Lohm.
C. Rostrum much elongated, constricted at its base, pyriform.	Palpi lateral, widely separated, appearing to be formed of only three joints.			6. SCAPTOGNATHUS, Trt.
	Palpi in contact above the rostrum, with four well-developed joints.			7. LEPTOGNATHUS, Hodg

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XXVI.—*The right Generic Names of some Amphipoda.* By the Rev. THOMAS R. R. STEBBING, M.A.

IN the 'Annals and Magazine' for December 1868, Norman defined a new genus *Helleria*, with *Helleria coalita*, n. sp., for the type. By a slip either of the pen or of the press the superior antennæ were said to be *with*, instead of *without* secondary appendage. That the superior antennæ were much shorter than the inferior was made a generic character. Earlier in the same year, 1868, as was subsequently pointed out by Eaton, the name *Helleria* had been given by Ebner to a genus of the Isopoda. The Amphipod genus, however, was left with its name unaltered until 1887. In that year E. Chevreux, having obtained specimens of both sexes of Norman's species, renamed the genus *Guernea*, with a Latin rendering of the original definition. In this he retained the statement that the upper antennæ have an accessory flagellum, but omitted the character describing them as longer than the lower antennæ, because he found that this did not apply to the female. In the same year, 1887, H. J. Hansen described his *Prinassus Nordenskiöldii*, n. gen., n. sp., without giving any separate generic definition. His single specimen was a female, in which the upper antennæ were rather longer than the lower, and had no accessory flagellum. There is every probability that his species is the same as Norman's *Helleria coalita,* and there can be no doubt that his genus is identical with that defined by Norman and Chevreux. Whether *Guernea* or *Prinassus* should have the priority is not so easy to decide. Chevreux's paper comes to hand as an "Extrait du Bulletin de la Société Zoologique de France, t. xii. 1887," and is dated on the cover as published in Paris, 1887. Hansen's paper similarly comes to hand as a "Særtryk af Vidensk. Meddel. fra den naturh. Foren. i Kjöbh. 1887," and is dated on the titlepage as published in Kjöbenhavn, 1887. Extracts from the 'Annals and Magazine' have the great advantage of showing the exact month in which the description of a new genus or species has appeared, but in the extracts above-mentioned there is nothing to indicate which has the priority. It would be a decided boon if, in all publications of the kind, this inconvenience could be remedied. In papers extracted from the reports, for instance, of our own British Association, there is in general nothing which decidedly shows whether they were published during the year in which they were read, or not till the following year. In the case of the Transactions of a Society for any given year, the presumption will be that they were not actually published till the year following, although in some instances parts of these Transactions may have been in fact issued while the year to which they refer was still current. It would save much trouble if "separate copies" were provided with an exact reference to the volume and paging of the work from which the excerpt is made, as well as with the true date, not of the reading, or not of that alone, but of the first actual publishing of the paper concerned.

It may be of interest to English readers to know that the genus *Eriopis*, Bruzelius, which Boeck identified with *Niphargus*, Schiödte, was reinstated in 1888 by the eminent Polish writer, Wrześniowski, who found that the maxillæ were distinct in the two genera. It appears, however, from Scudder's 'Nomenclator Zoologicus,' that *Eriopis* was preoccupied before its use by Bruzelius, and therefore, as *Opis* was altered into *Opisa*, I propose to change *Eriopis*, Bruzelius, into *Eriopisa*.

Dr. P. P. C. Hoek, recently appointed Director of the new Zoological Station at Helder, last year explained that his

Orthopalame Terschellingii had proved to be identical with *Microprotopus maculatus*, a genus and species described by Norman in the 'Annals and Magazine' for December 1868. The genus *Orthopalame* is therefore cancelled.

M. Jules Bonnier has also, during 1889, discovered and pointed out that in instituting the new genus *Dryope* in 1862, the late Mr. Spence Bate was in error in attributing two branches to the last uropods, and that, in fact, the genus *Dryope*, of which the name was preoccupied, is identical with the genus *Unciola*, Say. The uropods in question are difficult to observe, because, while above they are covered by the minutely scabrous telson, below they are almost concealed by the produced ventral plate of the sixth segment of the pleon. It may be questioned whether the inner branch of the third uropods in this genus is not rather coalesced with the peduncle than absolutely wanting. This is a point which some embryologist might decide.

Of the species which Dr. Julius Vosseler described last year among the Amphipoda of Spitzbergen under the name "*Amphitopsis dubia*, n. sp.," it may be said that there is great reason to regard it as identical with *Amphithopsis glacialis*, Hansen, 1887, although Hansen does not figure or mention the pair of apical setules which Vosseler notices and represents on the telson. Hansen suggests that his species ought possibly to be referred to Boeck's genus *Laothoës*, because the lower antennæ are longer than the upper. In Boeck's genus, however, it is the upper antennæ that are longer than the lower. Further, in *Laothoës* the first maxillæ have a little one-jointed palp, while Vosseler, at least for his "*Amphitopsis dubia*," figures the first maxillæ as having a large two-jointed palp. Boeck himself says that *Laothoës* was preoccupied by Fabricius among Lepidoptera in 1808, and therefore ought to be exchanged for some other name to stand among the Amphipoda. Scudder gives "*Laothoe*, Fabr. Lep. 1808, A;" and if this is correct, there will be no need to alter Boeck's generic name, but figures of *Laothoës Meinerti*, Boeck, are, I believe, still a desideratum.

BIBLIOGRAPHICAL NOTICES.

The Flora of Suffolk. By W. M. Hind, LL.D., assisted by the late Churchill Babington, D.D., F.L.S. London: Gurney and Jackson, 1889. Pp. xxxiv, 1–508.

In 1860 a 'Flora of Suffolk' by the Rev. J. S. Henslow and E. Skepper was published, the former of whom regarded himself as "a consulting but sleeping partner." This, which was issued more as an inducement to others to add to, than as complete, is now followed up by the present work, which, none the less that the author regards it as not pretending "to be an exhaustive account of the botany of Suffolk," is a great advance in the right direction, and shows that a large amount of information has been gathered together and utilized.

The book contains a Map of the County, introductory chapters treating of the Natural Features, Geology, Climate, Rainfall, and Distribution of Plants; a plan of the Flora, Books, MSS., Herberia, and Authorities; the Flora proper, with a chapter on Palæontological Botany; Tabular View of the Species of Suffolk and adjoining Counties; the flora of East Anglia and Holland compared; the Progress of Botany in Suffolk; Additions, Corrections, and Indexes.

What are the features that make the flora of an East Anglian county specially interesting to the botanist? There are two, the Fens and Broads, and the remarkable district called the "breck-lands." We may dispose of the Broads by saying that they are probably not much altered so far as plant-life goes by drainage and are mostly "growing-up," that is, becoming smaller by the growth of the surrounding vegetation, though they are nothing like botanically examined.

With the Fens the case is very different; in Suffolk a strip along the northern part of the county and perhaps a very small portion between Ely and Lakenheath is all that is in anything like a state of nature, such as Wicken Fen in Cambridgeshire *at present is.*

The flora of the "breck-lands" is perhaps the most local and specialized in Britain; many of the species are quite confined to these sandy heaths and warrens, and not only do the plants point to a former maritime condition, but the birds and insects also, and it seems probable that there are yet other species to be found in early spring.

The historical aspect of a flora is always of much interest; we cannot trace back our records more than three centuries with any certainty. Mr. D. Jackson has disposed of the supposed records by Scribonius Largus in Kent, and shown that they are *mythical.* Dr. Hind says "in some pre-Reformation glass in Gislingham Church the columbine (*Aquilegia vulgaris*) is represented; similar flowers have been recently found in the neighbouring parish of Yaxley by the Rev. W. H. Sewell, who regards the painting as the record of a plant grown on the spot in the fifteenth century or even earlier."

Of course this is, as the author observes, "a somewhat doubtful interpretation of an historical monument."

This is now not capable of proof, and the first record Dr. Hind has for Suffolk is the Sea-Pea (*Lathyrus maritimus*) by Caius (1555), quoted by Martyn in his ed. of Miller's 'The Gardener's and Botanist's Dictionary,' followed by those from Rev. Dr. Bullen (1562), Turner (1568), and Gerarde (1597), &c.

Taking the flora as it is written, the Map shows the county divided into five botanical districts founded on the political divisions for parliamentary purposes. This seems the mistake of an otherwise admirable book; what possible connexion the two can have it is difficult to see. It may at once be admitted that the county is not one that lends itself to easy division by the river-basins, now so generally adopted. Where even some modification of this has been attempted in conjunction with other natural features (as in a late 'Flora of Finland') the result is better than here given.

Dr. Hind gives the one (and *sole?*) reason in its favour—the ease of finding them on any ordinary map. Three of the districts in the east and the other two in the west nearly fall into the E. and W. Suffolk of Mr. H. C. Watson's Topographical Botany, his division of the county being the meridian of Greenwich, not a good one it must be admitted.

The introductory chapters are very well done, but it is time that under Climate the highest and lowest temperatures if given should be associated with what really affects plant-life, *i. e.* the aggregate amount of heat in summer and cold in winter, accompanied in the latter with some statistics of the snowfall; again, early spring temperatures are a great factor in plant-life, and especially April variations; the writer has known Channel-Island plants to survive 25° of frost in February, but succumb to 8° in April &c.

The author (with his *confrères*) has consulted or had entrusted to him a large number of local herberia, and, what is better, made good use of them. There seem to be very few improbabilities in the Flora proper; but under *Œnanthe* some revision is needed. It may very reasonably be suggested that *Œ. pimpinelloides* should be deleted and its localities in part relegated to *Œ. Lachenalii* and some perhaps to *Œ. silaifolia*? *Sisymbrium irio* should surely have been starred as an introduction; this has probably been accidentally omitted to *Sempervivum*. *Melampyrum sylvaticum* can hardly be that species; probably *M. pratense*, var. *hians*, Druce, is really the plant found. The authority for *Galeopsis dubia*, Leers, is not good enough to accept it as a Suffolk plant. Henslow and Skepper's record for *Lithospermum purpureo-cœruleum* is not mentioned; it was, however, hardly likely to have been a native at Bergholt.

The absences from a flora are always of interest; but when the county list and that of the adjoining counties is thrown into the tabular form consulting it becomes wearisome and the eye is apt to be misled. If the tabular form must be given, a list added after, of all the wants of the county, with indications of their distribution around, condensed as in Mr. Watson's works, would be of especial use.

Of the absences *Œnanthe crocata* may be noted; this is wanting in Cambridgeshire and a large portion of northern Essex, and, although given as a notable one, is perhaps not so, as on present knowledge it seems absent from Holland, Belgium, and Denmark. *Lathyrus montanus*, Bernh. (*Orobus tuberosus*), is a much more remarkable absentee, though wanting in Norfolk? and Cambridgeshire.

Potamogeton zosterifolius and *P. acutifolius* can hardly be really absent, though doubtless they will (if found) be very rare and local.

The chapter comparing the flora with that of Holland induces one to wish that this had been carried further, so little of such work has been attempted in British local floras. Being the work of the late Dr. Babington, Dr. Hind probably did right in so leaving it; none the less it is to be regretted. One plant, however, stated to be absent from Holland *is not so*, i. e. *Peucedanum palustre*, Mœnch., but occurs in many parts abundantly; doubtless the slip has occurred from the Dutch botanists putting it under the genus *Thysselinium*, Hoffm.; had it been absent it would have been a remarkable fact in distribution. *Arenaria leptoclados* and *Galium Vaillantii* are also Dutch species.

The chapter on "The Progress of Botanical Study in Suffolk" contains much interesting matter and satisfactorily concludes the work.

The writer would suggest that if a new edition is at any time undertaken a careful examination should be made of the material at Kew, in Smith's and Winch's herbaria at the Linnean Society, and in the British herbarium at the Natural-History Museum at Kensington; in the first two there certainly is additional matter, and though very time-consuming, the want, if known, may be filled by some one. In these matters we miss that kind and ever-helpful botanist the late Rev. W. W. Newbould.

Arthur Bennett.

The Fauna of British India, including Ceylon and Burma. Published under the Authority of the Secretary of State for India in Council. Edited by W. T. Blanford. *Birds.*—Vol. I. By Eugene W. Oates. London: Taylor and Francis.

In his able Preface the Editor of this series justly congratulates Indian ornithologists upon the acquisition of the services of the author of 'The Birds of Burmah,' a work which, from the excellence of its letterpress, deserves to be bracketed with Col. Legge's 'Birds of Ceylon.' From the scientific point of view the present volume and the two which are to follow will supersede the well-known and classic Jerdon, although many old Indians, who care little for classification, will continue to dwell with pleasure on the badly-printed pages from which they received their earliest lessons in bird-lore. In this they will be justified by the fact that Jerdon's work contains more ample notes on migration, habits, folk-lore, &c. than will be found in Mr. Oates's book, owing to the limits assigned by the authorities to the number and size of the volumes which make up this series. When we consider that the sum total of species enumerated by Jerdon will be exceeded in the present work by more than one half, the necessity for compression by the author will be obvious. The increase is largely due to the extension of the area now comprised in British India, but also to the number of additional species that have been recorded from localities which were little known in Jerdon's time, when such collections as those now in the

British Museum—the Hume, Tweeddale, and other representative series—were undreamt of.

In this instalment, which contains a great part of the Acromyodian Passeres, the arrangement of the families is new and to some extent based upon the plumage of the young birds, a character of unquestionable value as evidence of relationship. Mr. Oates begins with the Corvidæ, which he divides into three subfamilies—Corvinæ, Parinæ (Tits), and Paradoxornithinæ; and the position of the second will come as a shock to a good many old-fashioned systematists. While we think of it we may note, for correction in the errata, a slip of the pen on p. 16, line 19, where "eastwards" should be "westwards." Wisely, as we think, Mr. Oates has retained the Jackdaw in the genus *Corvus*, and has not placed it under *Colæus*; but, having done this, it seems inconsistent to put the Red-billed and the Yellow-billed Choughs each in a different genus, solely on account of the shape of their beaks. In the Paradoxornithinæ he makes a new genus, *Scæorhynchus* (p. 68). The next family—Crateropodidæ—contains *Rhopocichla* (p. 159), *Sittiparus* (p. 171), *Lioparus* (p. 174), *Hilarocichla* (p. 243), *Alophoixus* (p. 259), and *Xanthixus* (p. 274), gg. nn.; while we gather that *Criniger burmanicus* and *Molpastes humii* are here distinguished specifically for the first time, though no "sp. n." is inserted to catch the eye of the Recorder of Aves. In the Dicruridæ *Dissemurulus*, in the Certhiidæ *Elachura*, are gg. nn.; *Regulus* is raised to the rank of a family; the Sylviidæ, Laniidæ, Oriolidæ, Eulabetidæ, and Sturnidæ follow, and in the last there is a new genus, *Agropsar*. Woodcuts of the typical species or of their heads and feet add to the value of this carefully-written volume, which will for a long time hold its place as the standard work on Indian ornithology.

We would suggest that in the succeeding volumes a little more system with regard to proper names is desirable. As a rule, when we find simply Blyth, Jerdon, Anderson, or Stolickza, we understand that those naturalists are dead; but here, although Col. Godwin-Austen, Dr. Scully, Messrs. Hume, Blanford, Davison, and many others are happily still among us, their names seldom, if ever, have a prefix. In fact Col. Lloyd, Dr. Stewart (dead, we believe), Mr. Gammie, and Mr. Bligh are among the few thus distinguished; and, remembering the wrath-appeasing reply of the subaltern to Lord Gough—"Sir, we never say *General* Alexander or *General* Cæsar"—this exceptional and distant politeness seems somewhat invidious.

MISCELLANEOUS.

Mimicry of the Environment in Pterophryne histrio. By Mr. J. E. Ives.

The author stated that his attention had been drawn to the remarkable resemblance of the colour-markings of the Frog-fish to the Sargassum weed in which it lives. This fish is a member of the

Pediculati, and shares the sluggish habits common to the group. On account of the elongation of the carpal bones and other peculiar modifications, they have poor powers of swimming, their structure being adapted to moving about on the bottom, among corals, seaweed, and other low forms of life, which they closely resemble in colour and in many points of outline. By this resemblance they are concealed both from their enemies and their prey. The member of the group best known is the common Fishing-frog, *Lophius piscatorius*, whose remarkable mimicry of its surroundings has been well described by Mr. S. Kent. In the genus *Antennarius*, closely related to *Pterophryne*, the species present wonderful similarity of colour to the forms among which they live. Dr. Günther has paid considerable attention to this genus, and he has also given an excellent figure of *Pterophryne histrio*, under the name of *Antennarius marmoratus* *.

Pterophryne histrio is found among the floating masses of Sargassum weed in the warm seas. Here it makes its peculiar nest by binding together the fronds of the sea-weed with gelatinous threads, and depositing the eggs throughout the mass. The ground-colour of the fish is of a pale yellow, and on this light background are darker irregular brownish bands, closely resembling the branched fronds of the Sargassum weed. Along the edges of these darker bands, on the bands themselves, and also to a lesser extent upon the rest of the body, are little white specks of various sizes, on an average about that of a pin's head. On the belly, around the mouth, and on the dorsal spines, are numerous leaf-like cutaneous filaments. Mr. Ives stated that, after careful consideration, he had come to the conclusion that the colour-markings of the fish, and the cutaneous filaments, had been developed in mimicry of the *Spirorbis*-covered Sargassum weed. Professor Benjamin Sharp, who spent last winter in the West Indies, had informed Mr. Ives that on the Sargassum weed, of which he saw large quantities, were invariably scattered great numbers of *Spirorbis* shells. Professor Moseley in "Notes by a Naturalist on the 'Challenger'" (p. 567) speaks of the resemblance in coloration of the forms inhabiting the Sargasso Sea to the Sargassum weed. He attributes the white spots of *Pterophryne histrio* and also of some shrimps and crabs to mimicry of the patches of *Membranipora* that encrust the Sargassum weed. The white spots upon *Pterophryne histrio*, however, are much smaller than the patches of *Membranipora*, and are also much more striking to the eye. This latter fact appears to be due to the delicate fenestrated character of this Bryozoan. The patches of *Membranipora*, also, do not occur in the same abundance upon the Sargassum weed as do the *Spirorbis* shells. Professor Moseley probably confounded the numerous *Spirorbis* shells with patches of *Membranipora*. As far back as 1757, Peter Osbeck, describing this fish which he had met with in the Sargassum weed of the Atlantic Ocean while on a journey to the East Indies, said, with reference to the cutaneous filaments, "probably Providence has clothed it in this leaf-like manner, in order

* Journal des Museum Godeffroy, Heft xi. pp. 161–165, pls. 99–106.

that the predaceous fishes might confound it with the sea-weed, and therefore not exterminate it" *.—*Proc. Acad. Nat. Sci. Philad.* Nov. 5, 1889, p. 344.

On Seasonal Dimorphism in Japanese Butterflies. By Dr. Adolf Fritze.

Besides the nine Butterflies cited by Pryer † as seasonally dimorphous in Japan, namely *Papilio machaon*, L., *P. xuthus*, L., *P. macilentus*, Janson, *Pieris napi*, L., *Colias hyale*, L., *Terias multiformis*, Pryer, *Vanessa C-album*, L., *V. C-aureum*, L., and *Polyommatus phlœas*, L., two new ones occur, according to my investigations in the interior of central Japan in the summer of 1889, namely *Thecla arata*, Brem., and *Vanessa levana*, L.

Thecla arata, Brem., which has hitherto been regarded as single-brooded, has two generations which are markedly seasonally dimorphous, and this seasonal dimorphism shows itself especially upon the underside, while the upperside of both generations is uniformly blue; only the blue of the summer form is darker than that of the winter form. In the latter the ground-colour of the underside is dark greyish green, interrupted by three white bands of different breadth, to which are added on the hind wings several smaller white streaks. The lower angle of the hind wings is orange-red, with four black spots, the two upper ones having a bluish-white nucleus. It is this generation that Pryer has figured. It flies in May and June.

The summer generation, which flies in August, shows on the underside exactly the pattern of the spring generation, but instead of the greyish-green coloration we have here a dark brown, and in place of the white bands and streaks we find light brown ones; the orange-red of the angle of the hind wings is much less intense, and the bluish-white nuclei in the black spots disappear entirely or almost entirely.

Vanessa levana, L.—The seasonal dimorphism of the European form of this species has long been known; it occurs also in the Japanese form, although here other and very remarkable characters occur. Thus, while the summer generation, the so-called *prorsa* form, which flies in August, is exactly like the German form, the German spring generation, the *levana* form, is entirely wanting in central Japan. In its place appears a *prorima* form, which has a rather close resemblance to the form figured by Weismann in his 'Studien zur Descendenztheorie' pl. i. fig. 2. From this the Japanese *prorima* is distinguished chiefly by the greater prominence of the black spots and bands, by several brown spots at the root of the fore wings, and by a straight light brown transverse band upon the hind wings. This generation flies in May and June, and has hitherto been regarded as a distinct species, *Vanessa burejana*, Brem.—*Zool. Anzeiger*, January 13, 1890, p. 12.

* Peter Osbeck, Reise nach Ostindien und China. Aus dem schwedischen übersetzt von J. G. Georgi; Rostock, 1765, p. 400.

† Pryer, '*Rhopalocera Niponica.*—A description of the Butterflies of Japan,' Jokohama, 1886 and 1888.

THE ANNALS

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[SIXTH SERIES.]

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XXVII.—*On Abdominal Appendages in Hexapoda.* By E. Haase *.

In his celebrated memoir upon the development of the Great Water-Beetle (*Hydrophilus piceus*) A. Kowalewsky, in 1871, first called attention to the fact that in the embryo of an insect stages might occur in which certain abdominal segments bear appendicular structures homologous with the thoracic legs. He first observed such leg-rudiments on the first two abdominal segments, and then saw the posterior pair disappear, while the anterior remained longer in the form of small tubercles. These results of Kowalewsky's were extended by K. Heider in 1886 † so far that "at a certain period of development indications of the rudiments of extremities may be recognized on all the abdominal segments."

In 1877 V. Graber ‡ succeeded in establishing the occurrence of rudimentary appendages homologous with the legs on the first and second abdominal segments in a *Mantis* (*M. religiosa*).

In 1884 H. Ayers found that in an American Cricket

* Translated from the 'Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin,' Jahrg. 1889, pp. 19-29.

† Abhandl. d. k. preuss. Akad. d. Wiss. in Berlin, p. 42.

‡ 'Die Insecten,' i. fig. 1; and see Morphol. Jahrb. xiii. (1888), tab. xxv. fig. 18.

(*Œcanthus niveus*), soon after the segmentation of the blastoderm, an indeterminate number of paired tubercles are formed upon the abdomen, which exactly correspond to the first traces of the true thoracic legs, but of which only those on the first and last (?) segments are retained for any length of time.

Further, in 1884, W. Patten observed in a Caddis-worm (*Neophylax concinnus*) that, when the thoracic legs are about half-grown, a pair of rudimentary appendages are developed upon each of the first three abdominal segments. He also found * that in the embryo of the House-Cockroach (*Blatta germanica*) a considerable number of abdominal appendages are originally developed, but that they rapidly disappear down to the first pair.

Finally, V. Graber † has recently recognized within the eight pairs of abdominal stigmata the same number of undeveloped limb-rudiments, of which the appendages of the first abdominal segment especially, both in their position and their histological structure, were perfectly homologous with those of the thorax.

From these statements we obtain a fresh support for the supposition *that the existing Hexapoda are to be derived from polypodous myriopodiform ancestors.*

After Balfour (1880) had adopted this view, the author sought (in 1881) to determine that primitive form of the Tracheata from which both Myriopoda and Hexapoda were to be derived, and came to the result of adopting as such a hypothetical form, nearly allied to the recent order Symphyla, which is represented only by the single genus *Scolopendrella*, and this he named *Protosymphyla.*

The more accurate investigations of last year, specially furthered by B. Grassi's labours, already enable us to attempt the closer definition of the characters of these hypothetical forms by the elimination of such peculiarities as appear to have been acquired secondarily by the existing orders which come under consideration.

Notwithstanding that in the indefiniteness of the parts of its mouth, the simplicity of its body-segments, &c., it far exceeds all known Tracheata, *Scolopendrella* itself is to be regarded as a form secondarily developed in several directions, especially degeneratively. Thus its tracheal apertures are confined to the lower surface of the head, its visual organs are aborted, and its thirteenth pair of legs converted into a tactile organ, which yet possesses no ganglion. If the sexual

* Quart. Journ. Micr. Sci. 1884, p. 48.
† Morphol. Jahrb. xiii. (1888), p. 598.

organs by their being paired, as also by their rather ventral position on each side of the intestine, show a primitive condition, their opening in an unpaired slit *, placed behind the third pair of legs, appears to be of secondary origin.

The order Chilopoda also, as already urged by V. Graber and the author in opposition to F. Brauer, is above all excluded from being regarded as a direct ancestor of the Insecta, by the decided drawing up of the first pair of legs to form part of the mouth-organs, and, further, the asymmetrical development of the dorsally-placed sexual organs is to be regarded as secondary, although their aperture, situated close in front of the anus, shows the original type, still represented by the Annelid-like *Peripatus*.

To decide the question whether the postembryonal increase from 9 or 7 to 17 † or 13 leg-bearing segments common to the Chilopoda Anamorpha (e. g. *Lithobius*) and *Scolopendrella* is to be regarded as a phyletic repetition, or, as is more probable, as a secondary larval phenomenon, our knowledge is still insufficient; at any rate, in *Scolopendrella* the gemmiparous zone is situated in front of the subsequent thirteenth pair, and therefore, as in the Chilopoda, immediately before the preanal segment, and the insertion of new somites occurs from before backward, so that in both the hindmost pair of ambulatory legs is also the youngest.

The order Diplopoda stands in the closest relation to *Scolopendrella* by the intimate fusion of the last two pairs of jaws into a gnathochilarium, which appears as a simple appendage even in the first embryonic rudiment, and by the anterior, although separated, opening of their paired and decidedly ventrally-situated genital sacs (behind the second pair of legs); and their apparently double segments are to be accounted for by the union of two individual segments effected by the fusion of their dorsal plates, as demonstrated by Newport and since, among others, by the author, Latzel, and, recently, Heathcote. In point of fact the resemblance of the embryo *Iulus* to an insect-larva, which is so often referred to, is also so far purely superficial, that one of the thoracic segments ‡ has no appendage, and consequently the

* Successful serial transverse sections now enable me to confirm the union of the germ-sacs with the anterior unpaired slit, as stated by B. Grassi in 1884, in both sexes.

† In the Chilopoda referred to the poison-gland segment and also the preanal genital segment, which also bears jointed appendages, are included in the number 17.

‡ By analogy with *Scolopendrella nothacantha*, Latz. & Haase (=*Isabellæ*, Grassi), and *Pauropus*, and in accordance with Heathcote's view (Phil. Trans. vol. clxxix. (1888) p. 159), we must regard the *first* thoracic segment as the footless one.

third pair of legs of the Iulidæ must be referred to the abdomen.

As to the Pauropoda, they can only be regarded as ramifications of the great Protodiplopodan stem, degenerated by a subterranean mode of life, among other things the tracheal system having been completely lost, but which also in their genitalia and development still show throughout the fundamental form of this type, represented in a minor degree by *Polyxenus*, whilst their buccal organs and antennæ are aborted.

The examples of polypodism in the embryos of insects cited at the commencement had in common *the comparatively long persistence of the rudiments of the first pair of abdominal legs*, and recent investigations have even shown that, before their final disappearance, these may undergo special transformations. As long since as 1844 Rathke had observed peculiar "pilzhutartige Korper," also afterwards detected by Korotneff and V. Graber, and regarded them as "branchiform respiratory arrangements." Ayers also subsequently discovered on the same segment of the embryos of *Œcanthus* lateral excrescences of the ectoderm, which he described as vesicular appendages, united with the body by a short peduncle and lined with a layer of large cells, the cavities of which were connected with that of the body, and which he characterized as "branchiæ."

Further, in *Blatta*, W. Patten described the transformation of the leg-appendages of the first abdominal segment into similar "pear-shaped structures," but urged against their interpretation as branchiæ their thick cell-lining, and ascribed to them rather a sensorial function and a glandular one to their lining. The author has found similar appendages also on the first abdominal segment of tolerably mature embryos of *Periplaneta orientalis*.

While in *Hydrophilus*, according to V. Graber, the appendages of the first abdominal segment persist in the rudimentary state, on the embryo of the Cockchafer they show, according to the same naturalist, a considerable increase in size. As early as the seventeenth day * they have become comparatively stronger in growth than the typical legs, while "the originally very inconsiderable rudiments of the other (abdominal) segmental appendages have entirely disappeared"—nay, they finally become much longer than the thoracic legs and almost three times as broad. They then form a soft sac which is united with the body by a short peduncle, lined with large ectodermal cells and filled internally with meso-

* Morphol. Jahrb. xiii. (1888) p. 599.

dermic elements, but which possesses neither muscles, nerves, nor tracheæ. With the thirtieth day commences the retrogression of the abdominal sacs, and "on the excluded embryo we can find only the closed-up scar of its peduncle."

Conditions like those of the embryonic development of the insects just referred to are to be found *persistent* in the mature representatives of a section of Hexapoda, which, although nearly related to the Orthoptera, has been justly separated by F. Brauer from the other insects as "Apterygogenea," which never have possessed wings.

Thus in *Campodea*, the genus of Thysanura which in general stands nearest to the primitive form, there are leg-like appendages upon the first abdominal segment, and these in young animals are comparatively more strongly developed than in the adults; at the same time the whole ventral surface of this segment, by the abundance of cells and staining faculty, reminds one of embryonic tissue. The appendages are seated in the same direction as the thoracic legs, and also show an indistinct articulation into two or three joints. Thus only the portion of the ventral plate which is situated between them is to be regarded as the "ventral shield." The aborted musculature of these leg-rudiments, which completely resemble the developing extremities of the Symphyla, is also to be deduced from that of the thoracic legs, and in their segmental division, such as appears characteristic of mesoblastic appendages, it is traceable to the last joint of the rudiment. On the next (second) abdominal segment instead of the leg-like appendage there appears externally a cheliform movable piece, and within a cutaneous sac lined with very large hypodermic cells in part glandularly developed, which is protruded by the inflow of blood and retracted by special longitudinal cutaneous muscles attached to it at the apex. Towards the end of the body, at least to the extremity of the seventh abdominal segment, the planing down of the duplicatures and their fusion with the ventral shields gradually becomes more and more intense, at the same time the cutaneous sacs decrease in size, and the cheliform spur increases, so that even on this account the former may be claimed as older formations. At the eighth abdominal segment the saccules return within the body and at the same time come together in the middle in front of the opening of the sexual organs; as in *Japyx*, the movable abdominal spurs are wanting from this segment onwards also in *Campodea*.

In the largest representative of the Thysanura, *Japyx gigas*, there is on each side of the narrow, unpaired ventral shield of the first abdominal segment a tripartite mass of glandular cells, immersed like a pocket, and united with retractor muscles and nerves, the efferent ducts of which lead into peculiar hollow capillary processes, so that one is reminded of the scent-glands of *Periplaneta* and *Corydia*; in *Japyx solifugus* the glandular mass is simple and less developed. In all species of *Japyx* there is at the margin of the duplicature which represents the rudiment of a leg, and amalgamates with the ventral shield, an unjointed movable chitinous appendage, exactly like an ordinary *terminal spur* (calcar).

As in *Campodea*, there are also in *Nicoletia*, according to B. Grassi *, ventral sacs and spurs from the second to the eighth abdominal segments; with regard to the important conditions in the first abdominal segment Grassi unfortunately says only:—"the false feet, and, I believe, also the vesicles, are wanting." In *Lepismina*, which, according to Grassi, possesses abdominal spurs only on the three penultimate segments, there is on each of the abdominal segments 1–8 "a pair of organs comparable with the segmental vesicles" (ventral sacs). In *Lepisma* the ventral sacs are entirely wanting, while the abdominal spurs may occur from the seventh to the ninth segment.

The ventral sacs and spurs are most highly developed and have been longest known in the genus *Machilis*, which was regarded by P. Mayer as particularly near to the primitive insects. The ventral sacs were described as long ago as 1836 by Guérin, as delicate, protrusible vesicles at the hinder margins of the ventral plates, which he regarded simply as resembling the branchiæ of the lower Crustacea. After the discovery of the tracheæ by H. Burmeister and C. T. von Siebold, this interpretation was rejected by the latter, but it has been revived by the most recent investigator, J. T. Oudemans. On the first abdominal segment there is one, on each of the four following segments two, and on each of the others a pair of delicate membranous sacs of considerable size, which are protrusible by the inflow of blood. They are covered with a transparent, perfectly smooth and solid chitinous cuticle, the partly glandular matrix-layer of which contains distinctly limited, flat cells with large nuclei, and they have their own nerves and strongly transversely striated retractor muscles; tracheæ never enter them. On the first abdominal segment the movable spurs which are elsewhere articulated outside the sacs are wanting, but this is probably to be regarded less as a primitive condition than as a sup-

* Boll. Soc. Ent. Ital. xviii. (1886), p. 6, and xix. (1887), p. 7.

pression of the structure, due to the bending of the abdomen, which is angularly applied to the thorax.

Organs which we may regard as homologous with these ventral sacs are met with first among the Chilopoda in the genera *Lithobius* and *Henicops*, standing still nearer to the Protosymphyla, in the coxæ of the last four, or more rarely five, pairs of ambulatory legs, where they occur as thread-spinning coxal glands. In the Scolopendridæ and Geophilidæ, derived by elongation from the shorter primitive forms, analogous organs, here characterized as pleural glands (on account of the union of the coxæ with the pleuræ), occur in the last leg-bearing segment.

Among the Symphyla a lobiform plate appears in *Scolopendrella immaculata* on the coxæ of the second pair of legs, and this in the next segment is transformed into a ventral sac which is only slightly protrusible. The distal part is covered with a transparent homogeneous chitinous cuticle, and lined with a few gland-like hypodermic cells. Below this layer of cells lies the reticulated tissue of the adipose mass, through which blood-corpuscles pass into the ventral sac. Outside of this coxal saccule, as we must call it here, there is to the thirteenth segment a claw-like appendage increasing in size posteriorly, which can by no means be regarded as the rudiment of a leg, but only as the product of transformation of a joint-spur, and which occurs similarly on the two posterior pairs of coxæ in *Machilis* *. On the twelfth segment the coxal sac is reduced to a softer, oval, membranous piece; in the undeveloped legs of young animals we find no trace of appendages on the coxæ.

In the order Diplopoda also protrusible sacs situated in the coxæ are often present; thus they occur in the anterior segments in Chordeumidæ and *Lysiopetalum*, as well as in the section of the Colobognatha derivable from the Chilognatha, in *Polyzonium* and *Siphonophora*, and indeed they appear first, and at the same time most strongly developed, on the third pair of legs, the somite of which would therefore correspond to the first abdominal segment of the Hexapoda.

As these ventral sacs in the coxæ of the Myriopoda, or at the posterior margins of the ventral plates of the Thysanura, usually occur at the end of partially unconnected developmental series, we are compelled to assume their probably polyphyletic development within the order. And yet, in their position, in their origin, and at the same time in their

* To what extent such structures, originally equivalent to the ordinary cutaneous setæ, can become developed, is shown especially by the tibial spur, *e. g.* of the Heterocera.

histological structure they show so many common features, that we may, with H. Eisig *, think of them as repetitions of old inherited tendencies. To this may be added that in the pterygote Insects referred to they likewise occur during embryonic life in a position relatively to the limbs which corresponds with that demonstrated in the Thysanura and Symphyla, inasmuch as the vesicular sac is always situated within the coxal joint or the leg-like abdominal spur, just as V. Graber has indicated in the development of *Hydrophilus* †.

Now to glance at the physiological significance of the ventral sacs, it seems probable, from the developmental history of *Œcanthus*, and especially of the Cockchafer, as already assumed by H. Ayers and V. Graber, that in these Insects they perform secondarily a *respiratory* function, which can only be regarded as a special development of cutaneous respiration (the above-mentioned embryos, in the egg, lying generally in moist earth), as the dorsal vessel and tracheæ are not yet in action when these ventral sacs possess their highest development. That in the Symphyla and Thysanura also the ventral membranous sacs have a similar *respiratory*, and perhaps a specially excretory significance, is supported by the defective or aborted development of the tracheal system and the ventrally concealed position of the stigmata in these forms.

Thus *Scolopendrella* has only cephalic stigmata, the tracheæ from which extend exactly into the third segment, onward from which the coxal membranous sacs occur. So also *Campodea* has stigmata only on the three thoracic segments, and these lead into feebly developed tracheæ; and *Nicoletia*, according to Grassi, forms only delicate dorsal longitudinal trunks, and feeble ventral transverse anastomoses, so that here also the tracheal system appears to be only feebly developed. In *Machilis*, again, the longitudinal trunks are entirely wanting, and the feeble abdominal tracheæ present only a slight ramification. According to the observations of J. T. Oudemans (and the same thing was observed by the author in the open) *Machilis* in captivity extruded its ventral sacs, especially if it were in a warm and at the same time moist atmosphere, but always only when it was perfectly quiet; this is against the one-sided conception of the ventral sacs as defensive arrangements analogous to the fleshy forks of the Papilionid larvæ, for example, seeing that the latter come into action only when their bearer is disquieted.

* Monographie der Capitelliden &c. in Fauna und Flora von Neapel &c. xvi. (1887), pp. 371–403.

† Morphol. Jahrb. xiii. (1888), p. 605.

In favour of at least the partially respiratory function of their ventral sacs, the feeble development of the tracheæ in the above-mentioned Diplopoda and Collembola may be cited; in the latter the ventral tube, which is often very extrusible, corresponds to the first pair of ventral sacs of the Thysanura, and stigmata occur at the utmost (*Sminthurus*) on the anterior margin of the prothorax. Further in favour of this function is the fact of the deficiency of the ventral sacs in those Thysanura which possess a more highly developed tracheal system of the Orthopterous type, with strong ventral longitudinal trunks, such as *Japyx gigas* and *solifugus*, *Lepisma* (and *Lepismina*?). On the first abdominal segment of *Japyx*, the decidedly glandular function of the ventral sacs, as in the Chilopoda, which, according to H. Eisig (*l. c.* p. 392), is to be regarded as the primitive one, has apparently alone persisted. Any special glandular functions of the ventral sacs in other forms still need more accurate observations, which the author hopes to make very shortly.

That in reality the ventral sacs, of the Collembola for example, perform other functions is rendered probable by some observations upon the living animal, the results of which, however, are contradictory; thus Nicolet, Olfers, Lubbock, and Tullberg ascribe to the ventral tube the action of an adherent organ, while O. Reuter regards it as an arrangement for the reception of water; in *Macrotoma*, again, A. Sommer has described large, unicellular glands, opening by a pore.

The ventral sacs of *Machilis* also show upon the dorsal surface a special glandular epithelium of much thickened, sharply defined cells, the plasma of which breaks up into fine, close cords, just as has been demonstrated by A. Weismann and C. Grobben for the excretory antennal glands of the Crustacea.

XXVIII.—*On the Nomenclature of the Oral Folds in the Shells of* Clausilia. By Edgar A. Smith, F.Z.S., and B. B. Woodward, F.G.S.

[Plate XI. A, figs. 1–4.]

It is well known to all conchologists that among the distinguishing features of the genus *Clausilia* the folds (*plicæ* and *lamellæ* as they are variously termed) within the aperture or mouth of the shell are especially characteristic.

They have been extensively relied on by specialists in formulating subdivisions of the genus, and hence a definite and correct nomenclature becomes of the highest importance to the student.

On this account, and in hopes of reducing to order the confusion which has arisen through the various applications of some of the terms, these notes have been put together and the accompanying explanatory table with the figures prepared.

Most of the available published descriptions are, unfortunately, either like those of A. Schmidt, unaccompanied by the figures so indispensable to their right understanding, or, where figures are given, as in Fischer's Manual, both are inadequate, since folds shown in the cuts are neither lettered nor described; indeed, we are free to confess that without an appeal to Cæsar certain points would still have remained doubtful in our minds.

Dr. Böttger, from whom aid was naturally sought in a question affecting a subject of which he is so perfect a master, not only most kindly afforded in writing the information desired, but also took the trouble to prepare and send over marked specimens *, so that no doubt now remains respecting the correct identification of Schmidt's nomenclature.

For many reasons it seems best to employ the Latin terms which have been applied to these folds or plaits. Moreover, since the German specialists have carried the study in connexion with them furthest and have framed the most complete system of nomenclature, it appears most advisable to adopt Dr. Böttger's modification of Schmidt's terminology.

In the accompanying table (facing this page), to save space, these Latin terms are placed together in the first column, lettered to correspond with the figures, and not repeated, where the vernacular equivalents occur, in the following ones. By referring to this table and the illustrations the signification of any term employed by the authors quoted can be seen at a glance.

Perhaps it may not be out of place here to briefly sketch the history and development of this system of nomenclature.

Rossmässler appears to have initiated it. In 1835† he designated the two principal folds on the columellar lip as the *lamella superior* and *lamella inferior*, and named the *interlamellare* between them. A little later (1836)‡ he distinguished

* Now in the Natural-History Collection of the British Museum.
† Iconog. pt. i. p. 75.
‡ *Op. cit.* pt. iii. p. 8.

essin, 876.	Moqne,	Rossmässler, 1835–36.
lle.		Lamella superior.
....	..	Interlamellare.
ielle.	re.	Lamella inferior.
lte.	llaire.	Columellarfalte.
	(ou, sc	
ıelle.		
	Plis p ...	Gaumenfalten.
ıumenfalte.	sup	
	deu	
Gaumenfalte.	troi	
	etc asilaire.	
aumenfalte.	infe	
e.	...	Mondförmige Falte.

Terminology recommended.	Böttger, 1877 (Westerlund and von Möllendorff).	A. Schmidt, 1868.	Fischer, 1881.	Kobelt, 1878.	Clessin, 1876.	Moquin-Tandon, 1855.	Dupuy, 1850.	Pfeiffer, 1848.	Cantraine, 1841.	Rossmässler, 1835–36.
On the Columellar Lip.										
a. Lamella superior.	Oberlamelle.		Lamelle pariétale.	Oberlamelle.	Oberlamelle.	Lamelle supérieure.		Lamella supera.	Pli pariétal.	Lamella superior.
a'. Lamellæ interlamellares.	Interlamellare.		Plis interlamellaires.	....	....	Plis interlamellaires (Plicæ interlamellares).		....	....	Interlamellare.
b. Lamella inferior.	Unterlamelle.		Lamelle columellaire.	Unterlamelle.	Unterlamelle.	Lamelle inférieure.		Lamella infera.	Pli columellaire.	Lamella inferior.
c. Lamella subcolumellaris.	Subcolumellarlamelle.	Subcolumellarfalte.	Pli subcolumellaire.	Subcolumellarfalte.	Spindelfalte.	Pli columellaire. (ou, sous-columellaire).		Plica subcolumellaris.	Pli subcolumellaire.	Columellarfalte.
On the Columellar Wall (not visible from without).										
d. Lamella parallela.	Parallellamelle.									
e. Lamella fulcrans.	Lamella fulcrans.									
f. Lamella spiralis.	Spirallamelle.		Pli spiral.	Spirallamelle.	Spirallamelle.					
g. Lamella inserta.	Lamella inserta.									
On the wall of the Outer Lip.	Gaumenfalten.					Plis palataux.	Plis palataux.	Plicæ palatales.	....	Gaumenfalten.
h. 1, 2, 3, &c. Plicæ suturales.	1, 2, 3, &c. Plicæ suturales.	Plicæ (or, plicu-læ) suturales. 1, 2, 3, &c.	Plis palataux.	Suturalfalten.	Obere Gaumenfalte.	supérieur, ou premier. deuxième.	premier. deuxième.	(*a*) superæ	Pli sutural.	
i. Plica principalis.	Plica principalis.			Principalfalte.	Mittlere Gaumenfalte.	troisième. etc.	troisième.	(*b*) inferæ.	Pli basal, ou basilaire.	
k. 1, 2, 3, &c. Plicæ palatales.	1, 2, 3, &c. Plicæ palatales.	2, 3, 4, &c.		Gaumenfalten.	Untere Gaumenfalte.	inférieur, ou dernier.	etc.			
l. Plica lunata (or, Lunella).	Mondfalte.		Pli lunulé, ou, Lunelle.	Mondfalte.	Mondfalte.	Pli lunulé, ou, Lunelle.		Lunella, or, Plica lunata.	. ...	Mondförmige Falte.

the following:—*a.* Gaumenfalten, *plicæ palatales*; *b.* Columellarfalte, *plica columellaris*; [*c.*] Die mondförmige Falte, *plica lunata.*

In 1841 Cantraine* sought to establish the terms which appear under his name in the table. Some of these are still employed by the French school of conchologists.

Fortunat Forster, in 1842 †, proposed a series of names which, inasmuch as they were somewhat fanciful and introduced no new or useful point, may here be passed by.

The systems of Rossmässler and Cantraine were correlated in 1848 by Pfeiffer ‡, who subdivided the *plicæ palatales* into (*a*) *superæ*, and (*b*) *inferæ.*

Up to this period only those folds visible within the mouth, or whose existence could be traced through the semitransparent shell, had attracted attention; but in 1850 A. Schmidt§ first described the *lamella spiralis* and employed it for the purpose of classification.

Dupuy (1850)‖ followed Rossmässler and Pfeiffer, but added to the list a *Callus palatalis* (Pl. XI. A, fig. 4, *c.p.*). This, however, judging from the example quoted—*Clausilia phalerata*, Ziegl. = *C. fimbriata*, Mühlf.—is merely a thickening of the shell-wall in a narrow tract running nearly parallel to the lines of growth, and consequently at right angles to the true folds. He also gave an explanatory figure of such folds as are visible within the aperture.

In 1853 Caillaud¶ discussed the lamellæ and gave a good dissected figure showing their arrangement in the interior of the shell, but he omitted all reference to the plicæ; and, although he correctly figured the *lamella inserta*, made no allusion to it.

Moquin-Tandon (1855)** merely followed Dupuy in every particular.

The terminology at present in use was practically perfected by A. Schmidt in 1868††, when he introduced the terms *lamella parallela*, *lamella fulcrans*, and *lamella inserta.*

* "Malacol. Médit. et littorale," Nouv. Mém. Acad. Roy. Bruxelles, xiii. no. 7, pp. 144, 145.

† Nova Acta Acad. Cæs.-Leop. Carol. Nat. Cur. xix. pt. ii. pp. 251–282 (one plate).

‡ Monog. Helic. Vivent. ii p. 395.

§ Zeitsch. f. Malakozool. 1850 (1851), p. 186.

‖ Hist. nat. Moll. France, pp. 339, 340 (note).

¶ Journ. Conch. iv. pp. 419–424, pl. xiii. fig. 4.

** Hist. nat. Moll. terr. et fluv. France, tom. ii. p. 316.

†† 'System europäisch. Clausilien,' pp. 6–8.

Clessin (1876) * omitted these, and introduced some slightly different vernacular names for certain of the others.

Schmidt's system was followed by Böttger (1877) †, who slightly modified (as noted in the table) the method of enumerating the *plicæ palatales*. To this modified scheme Westerlund and Von Möllendorff have given their adhesion, and it is the one adopted in the first column of the table as being the fullest and most satisfactory.

Kobelt (1878) ‡, like Clessin, omitted to mention the folds described by Schmidt in 1868, and, in addition, restricted the term "Gaumenfalte" to the *plicæ palatales*.

Fischer, in his Manual (1881, pp. 484, 485), gave some useful figures; but, as already noted, his nomenclature is imperfect, the work of his German contemporaries being overlooked.

Finally, Von Martens (1883) § gave a figure with the vernacular names of the principal folds, but, strange to say, made no reference to those on the columellar wall.

It may be as well to draw attention to the fact that those plaits which occur on the columella itself and on the columellar wall above are called "lamellæ," whilst, on the other hand, those only which are met with on the outer wall of the body-whorl are designated "plicæ." If this application of the terms *plicæ* and *lamellæ* be universally adopted a good deal of misapprehension and confusion will be avoided.

As regards the meaning and origin of these curious depositions—for they are such, and not in any strict sense folds—the present is not the time or place to enter into any speculations; but the following points deserve attention:—

1. The *lunella* is sometimes replaced by a series of very short plicæ ranging one above the other in such a manner as to suggest the very strong probability that this fold arose from their coalescence.

2. In the same way the *lamella fulcrans* would seem to result from a thickening of part of the *l. spiralis*, which blends with the similarly thickened *l. inserta*, till they spread across to the neighbouring folds; for when *l. fulcrans* is present *l. spiralis* and *l. inserta* are so reduced as to be scarcely perceptible if they be not altogether lost.

It must be understood that the figures here given are more

* Deutsch. Excur. Moll. Fauna, p. 227.

† 'Clausilienstudien.—Palæontographica,' Supp. iii. p. 10.

‡ 'Illustrirtes Conchilienbuch,' p. 285.

§ 'Die Weich u. Schalthiere,' pp. 136-138.

or less diagrammatic and that the *position*, rather than a correct delineation, of the various folds is sought to be indicated, with the view of introducing in a single figure as many of them as possible, since all are not present in any one species.

EXPLANATION OF PLATE XI. A.

Figs. 1–3. Diagrammatic sections of a shell of *Clausilia* with portions of the shell-walls removed, to show the positions of the various *lamellæ*. 1, front view; 2, back view; 3, seen from below.

Fig. 4. Front view, with outer wall and columella removed, to show the *plicæ*.

a–l. These letters correspond with those prefixed to the terms given in the first column of the table.

cl. Clausilium. *s.* Sinus.
c.p. Callus palatalis. *sut.* Suture.

XXIX.—*Descriptions of new Species of Lepidoptera from Central America.* By Herbert Druce, F.L.S., F.R.G.S., F.Z.S.

The new species will be figured in the 'Biologia Centrali-Americana.'

Fam. Sphingidæ.

Subfam. *Sphinginæ.*

Oryba, Walk.

Oryba imperialis.

Clanis imperialis, Druce, Biologia Centrali-Americana, Heterocera. vol. i. tab. iii. fig. 1 (1883).

Primaries and secondaries bright green: primaries crossed about the middle from the costal to the inner margin with a wide band of darker green, edged on each side with a greyish line, the base dark brown; a convex wide black line extends from the apex to the anal angle; a narrow brown line crosses the wing beyond the middle from the costal to the inner margin; each side of the line is irrorated with greyish scales; the fringe brown, excepting just at the anal angle, where it is yellow: secondaries crossed by two black bands, the outer band being the widest and thickly irrorated with greyish scales at the anal angle; the fringe bright yellow, excepting along the outer margin nearest the apex, where it is reddish brown. The underside of both wings bright orange-red, clouded with brown along the outer margins, both wings crossed beyond the middle by two narrow brown lines: primaries with a dark brown line extending from the apex to the middle of the outer line, crossing the wing. The upperside of the head, thorax, and the abdomen dark green, the tegulæ tipped with brown; the abdomen banded with black and with black and yellow spots at the sides and several patches of bluish-grey scales down the middle. The underside of the head, thorax, and abdomen bright orange-red; the antennæ and legs dark brown. Expanse 5 inches.

Hab. Panama, Chiriqui (*Ribbe,* type *mus. Staudinger*); Peru (*mus. Druce*).

This very fine insect is allied to *Clanis achemenides*, Cram., specimens of which are before me from Colombia. Walker's *Oryba robusta* is without doubt conspecific with *C. achemenides* and should now be placed in the genus *Oryba.* A fine specimen of *Oryba imperialis* is in the Oxford Museum from an unknown locality.

Fam. **Arctiidæ.**

Halisidota, Hübn.

Halisidota labaca, sp. n.

Primaries pale brownish yellow, with a small orange-coloured spot close to the base, three large spots along the costal margin, a large elongated patch on the outer margin, and two rather broad streaks on the inner margin partly crossing the wing towards the middle, all pale brown: secondaries pale yellowish white, partly hyaline near the base. The underside of the primaries as above, but with all the markings more indistinct. The head and thorax the same colour as the primaries; the abdomen above orange, the anus and the underside whitish; the legs and antennæ orange-brown. Expanse $2\frac{1}{4}$ inches.

Hab. Mexico, State of Jalisco (*Richardson*).

A very distinct species, but nearest *H. cinctipes*, Grote.

Euhalisidota, Grote.

Euhalisidota agelia, sp. n.

Primaries and secondaries uniformly greyish hyaline white; primaries crossed by three very faint yellowish-brown lines. The head, thorax, and abdomen yellowish white; antennæ pale yellowish brown; legs and underside of the head, thorax, and the abdomen yellowish white. Expanse $1\frac{1}{2}$ inch.

Hab. Mexico, State of Jalisco (*Richardson*).

Sallæa, Felder.

Sallæa lacipea, sp. n.

Primaries white, with a broad >-shaped black mark at the anal angle, extending partly along the inner margin, but not nearly reaching the base of the wing, the upper part of the > reaching the end of the cell; the fringe black just below the apex: secondaries white, the inner half broadly black, but not reaching the base. The underside of both wings the same as above. The head and tegulæ white; the thorax and upperside of the abdomen deep black; the sides, anus, and the underside of the abdomen dark orange-yellow; the antennæ and legs black. Expanse 2 inches.

Hab. Guatemala, in the city (*Rodriguez*).

This species is allied to *S. ochrosterna*, Felder, from which it is at once distinguished by the entirely white costal margins of the primaries. We have received five males captured at the electric light in the city of Guatemala. The female is unknown.

Fam. **Lithosiidæ.**

Eudule, Hübn.

Eudule bada, sp. n.

Primaries and secondaries hyaline orange-yellow; the primaries crossed from the costal to the inner margin by two indistinct, waved, blackish bands. The head, thorax, abdomen, and legs orange-yellow; the antennæ black. Expanse $\frac{3}{4}$ inch.

Hab. Mexico, Volcan de Ixtaccihuatl 11,500 feet (*Richardson*).

A small but very distinct species.

Fam. **Saturniidæ.**

Arsenura, Duncan.

Arsenura Richardsoni, sp. n.

Primaries and secondaries brownish fawn-colour, shaded with dark brown along the inner margin and near the base of the primaries; both wings are thickly irrorated with small black dots and a number of greyish scales near the base; a rather large lunular-shaped brown spot, edged with black, at the end of the cell; both wings crossed from the apex to the inner margin by a submarginal, rather wide, waved, black line, which follows the outline of the wings; the black line is edged on the outer side by a narrow fawn-coloured line; the outer margin of the wings is pale reddish brown, the fringe being the same colour; a black elongated spot close to the apex, below which are three madder-brown markings; the bases of both wings are thickly clothed with fawn-coloured hairs. The underside pale fawn-colour; the outer half of the wings is greyish white, thickly irrorated with pale brown; both wings are crossed by two very indistinct brown lines, the outer margins and the fringe pale brown. The head, thorax, abdomen, and legs brownish fawn-colour; the antennæ yellowish brown. Expanse $5\frac{1}{2}$ inches.

Hab. Mexico, Bolaños, State of Jalisco (*Richardson*).

In form this insect resembles *Arsenura erythrinæ*, Merian, and to some extent in coloration it is like *Saturnia pandora* of Klug. I have named this fine species after its captor Mr. Richardson.

Fam. **Lasiocampidæ.**

Gasina, Walk.

Gasina agdamea, sp. n.

♂. Primaries pale yellowish brown, shaded with dark brown at the end of the cell and near the base; the costal margin white, the veins beyond the cell white edged with dark brown, the inner margin near the base of the wing yellowish brown: secondaries pale cream-colour, darkest at the base and along the inner margin. The underside of both wings yellowish white, almost yellow at the base of the wings; the costal margin of the primaries edged with black nearly to the apex. The head, thorax, and abdomen yellowish brown, banded with white; antennæ pale cream-colour, tipped with white.

The female is almost the same as the male, but is considerably larger and has much less white on the primaries.

Expanse, ♂ $2\frac{1}{4}$, ♀ $2\frac{3}{4}$ inches.

Hab. Mexico, Coatepec (*J. Brooks*); Cuesta de Misantla (*M. Trujillo*); Guatemala, in the city (*Rodriguez*).

This fine insect is allied to *Gasina albicollis*, Walk., but it is entirely different in colour.

Gasina agesistrata, sp. n.

♀. Primaries and secondaries pale yellowish brown, without markings of any kind, excepting along the costal margin of the primaries, which are very faintly shaded with darker brown. The head, thorax, and abdomen yellowish brown, the underside of the abdomen and the legs dark brown, the antennæ yellowish. Expanse $2\frac{1}{2}$ inches.

Hab. Guatemala, in the city (*Rodriguez*); Honduras, Ruatan Island (*Gaumer*).

Two specimens of this insect, both females, very distinct from any known to me.

HYDRIAS, Herr.-Schäff.

Hydrias lacinia, sp. n.

Primaries semihyaline greyish white, with all the veins and the marginal line dark blackish brown; a broad white band, edged on both sides by two narrow, fine, brown lines, crossing the wing from the costal to the inner margin, and a submarginal waved white line extends from the apex to the anal angle: secondaries greyish, the costal and outer margin white, the hairs on the inner margin yellowish. The head, palpi, and front of the thorax yellowish brown; the thorax, base of the abdomen, and the anus blackish brown; the sides and underside of the abdomen, thorax, and legs yellowish brown; the antennæ greyish brown, darkest at the base. Expanse $1\frac{3}{4}$ inch.

Hab. Guatemala, in the city (*Rodriguez*).

A very distinct species, not nearly allied to any other known to me.

APATELODES, Packard.

Apatelodes lacetania, sp. n.

♂. Primaries blackish brown, crossed about the middle from the costal to the inner margin by a curved dark brown band; two black streaks close to the apex and several dark markings on the inner margin close to the base: secondaries greyish brown, the fringe of all the wings dark blackish brown. Underside dusky greyish brown; both wings with a submarginal white line. The head, thorax, and abdomen black, the tegulæ edged with greyish hairs; antennæ and legs black.

Female like the male, but larger and much paler in colour.

Expanse, ♂ $1\frac{1}{2}$, ♀ $1\frac{3}{4}$ inch.

Hab. Mexico, Omilteme, in Guerrero, 8000 feet (*H. H. Smith*).

A very distinct species. Mr. Smith captured both sexes in July 1888.

Fam. **Limacodidæ.**

Perola, Walk.

Perola lacipea, sp. n.

Primaries dark brown, with a reddish tinge near the base; a waved grey line crosses the wing from the apex to the inner margin and a short grey line extends from the costal to the middle of the outer margin: secondaries very dark brown, almost black. Underside of both wings uniformly blackish brown. The head, antennæ, and thorax reddish brown, the abdomen and legs dark brown. Expanse $\frac{3}{4}$ inch.

Hab. Mexico, Tierra Colorada, in Guerrero, 2000 feet (*H. H. Smith*).

One male captured by Mr. Smith in October 1888.

Semyra, Walk.

Semyra agemytha, sp. n.

♂. Primaries bright reddish brown, darkest at the base; a spot at the end of the cell, a waved streak on the inner margin close to the base, one near the anal angle, and one on the outer margin all metallic silvery: secondaries pale fawn-colour, palest at the base and along the inner margin; the fringe of both wings reddish fawn-colour. The head, thorax, and abdomen bright reddish brown, the anus yellowish; the antennæ and legs dark fawn-colour. Expanse 1 inch.

Hab. Mexico, Omilteme, in Guerrero, 8000 feet (*H. H. Smith*).

Mr. Smith captured one specimen of this pretty little insect in August 1888.

XXX.—*Descriptions of two new Central-American* Buprestidæ. By Charles O. Waterhouse.

Thrincopyge marginata.

Viridi-cyanea, nitida; capite crebre sat fortiter punctato; thorace fortiter punctato, disco subtilius punctulato; elytris depressis, sat fortiter striato-punctatis, late rufo-marginatis, apice truncatis, minute denticulatis.

Long. 8 lin.

Hab. Mexico, Kurango city (*Flohr*).

This beautiful species closely resembles *T. ambiens*, LeConte, but is broader, more shining, and slightly differently coloured, with no red border to the thorax, but a broader border to the elytra. The thorax is broader in front of the middle, and less evenly punctured, the punctures on the middle of the disk being small and those at the sides very coarse; the sides are more distinctly margined. The elytra are very similar, but have the apex of each more broadly truncate, the truncature being rectilinear. The prosternal process is very delicately and sparsely punctured. The visible part of the mesosternum is very obliquely narrowed posteriorly.

Although this species is so close to *T. ambiens* that at first I thought it might be merely an extreme variety, it is noteworthy that the mesosternum in the specimen described is separated from the metasternum. No doubt this is accidental; but, as there does not appear to be any fracture, it is evident that the connexion between the meso- and metasterna cannot be so intimate as in *T. ambiens*, in which they are completely connate.

Trypanidius Flohri.

Elongatus, parallelus, depressus, niger, sat nitidus; thorace creberrime evidenter punctato, medio sulcato, æneo tincto, lateribus rufo-velutinis; metathoracis episternis coxarumque posticarum parte externa rufo-velutinis.

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

Hab. Mexico, Navarrete (*Flohr*).

The head is slightly tinted with steel-blue, excavated at the upper part, sulcate at the lower part of the face, leaving two oval swellings. The thorax has the sides very gently arcuate; the disk is raised and longitudinally channelled in the middle, tinted with brassy green, closely and very distinctly punctured, and obliquely vermiculate-rugulose. The large lateral impression is filled with bright red, dull, velvety pubescence. The elytra are rather flat and horizontal, closely punctured with cuneiform punctures, with a rather smoother line indicating the usual costa; the apex of each is rather broadly rounded and denticulate. The prosternal chin-piece is very slightly emarginate in the middle. The prosternum is closely and rather roughly punctured, the process margined, narrowed at the apex. Lateral carina of the basal segment of the abdomen rectilinear posteriorly.

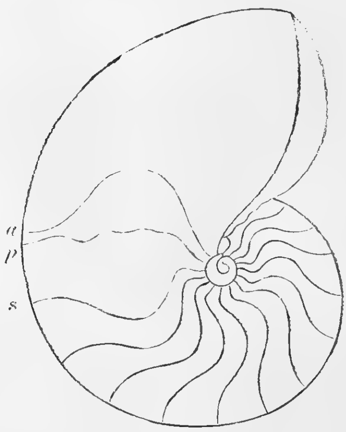
XXXI.—*On the Muscular Impressions of some Species of Carboniferous and Jurassic Nautiloids compared with those of the recent* Nautilus. By ARTHUR H. FOORD, F.G.S., and G. C. CRICK, Assoc. R.S.M., F.G.S., of the British Museum (Natural History).

IN the 'Geological Magazine' for November 1889 we described and figured the impressions of the shell-muscles of *Cœlonautilus cariniferus*, J. de C. Sowerby, sp.*, from the Carboniferous Limestone of Ireland. We have since had the good fortune to meet with other species in the British Museum Collection, both of Carboniferous and Jurassic Nautiloids, in which similar impressions are more or less completely preserved.

In the figures *a* indicates the anterior boundary of the muscular impression, *p* the posterior, and *s* the last-formed septum.

The accompanying figure (fig. 1) † of a cast ‡ of the interior of the shell of a recent Nautilus (*N. pompilius*) is

Fig. 1.



here introduced for comparison with the fossil forms to be described below. Upon the side of the body-chamber is seen the impression of the ear-shaped shell-muscle, together with part of the "annulus" or band that connects it with

* Min. Conch. vol. v. 1825, p. 130, pl. ccccIxxxii. fig. 3 (excl. fig. 4).

† Figs. 1–4 inclusive were all drawn on a reduced scale with the camera from the original specimens.

‡ To obtain the cast, the shell having been longitudinally sectioned, one half was filled with paraffin and then immersed in dilute hydrochloric acid until the shell was completely dissolved.

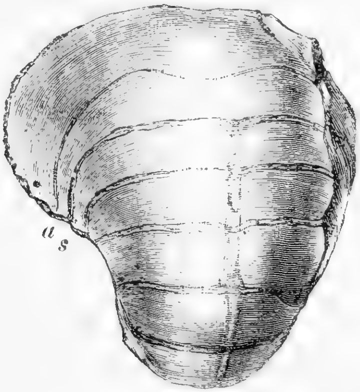
the corresponding impression on the other side *. Both in recent and fossil species the upper or anterior boundary of the impression (*a*) is much more distinctly marked than the lower or posterior (*p*), and accordingly the latter, as would naturally be expected, is rarely preserved in fossil forms. On the inner surface of the shell the anterior boundary of the impression is marked by a very fine sharp ridge, which therefore in the cast appears as a distinct groove. The impression of the annulus is not quite so distinctly marked.

(a) *Carboniferous Species.*

Solenocheilus latiseptatus, de Koninck, sp.†

Fig. 2 represents a natural cast ($\frac{1}{3}$ nat. size) of *Solenocheilus latiseptatus* from the Cement-stone of Carboniferous age of the Arden Quarries, Nitshill, near Glasgow (B.M. No. C. 2549 *b*). Only the anterior boundary (*a*) of the muscular impression is preserved, and that in the shape of a groove; but it shows that in this highly inflated form, with an evenly rounded periphery, the annulus connecting the two muscles of attachment was very short on the ventral side, so that the muscles were rather more ventral than lateral; whereas in those species having a more or less flattened periphery, e. g. *N. pompilius*, *N. polygonalis*, &c., the reverse is the case, the annulus being much longer on the ventral side.

Fig. 2.



* The appearance of the shell-muscle and annulus as seen on the body of the *Nautilus*, with which the impression here figured closely agrees, is admirably figured in Sir Richard Owen's 'Memoir on the Pearly Nautilus,' 1832, plate 1.

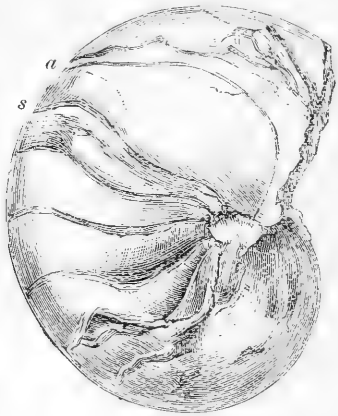
† 'Faune du Calcaire Carbonifère de la Belgique' (Ann. du Mus. Roy. d'Hist. Nat. de Belgique, tom. ii.), 1878, p. 110, pl. xxii. figs. 1, 2, 3.

(b) *Jurassic Species.*

Nautilus, sp. nov.

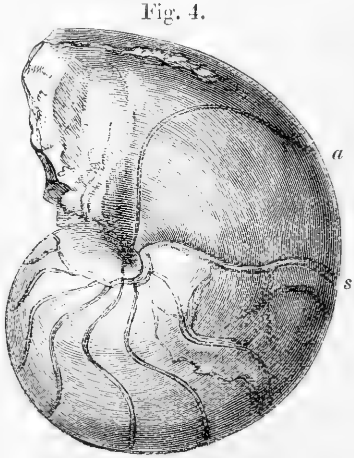
Fig. 3 illustrates ($\frac{1}{3}$ nat. size) a specimen (B.M. no. 69767) of a new species of *Nautilus* from the Inferior Oolite of Sherborne, in Dorsetshire. On the side of the specimen that is

Fig. 3.



figured the anterior boundary of the muscular impression can be traced as a groove from the umbilicus with but slight interruption to the periphery. Upon the opposite side, which is denuded of the shell and much eroded, only traces of the impression can be made out.

Fig. 4.



Nautilus polygonalis, J. de C. Sowerby *.

Fig. 4 represents ($\frac{1}{3}$ nat. size) a specimen of *Nautilus*

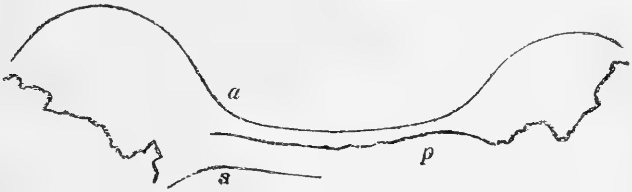
* Min. Conch. vol. vi. 1826, p. 56, pl. dxxx.

polygonalis (B.M. no. C. 2847) from the Inferior Oolite; the locality is not recorded. It is a longitudinal section of a shell and shows the course of the anterior boundary (*a*) of the muscular impression from the umbilicus to the periphery. Not only does this muscular impression greatly resemble that of the recent *Nautilus* (*N. pompilius*), but the curvatures of the sutures are also nearly identical, as may be seen by comparing them with those of fig. 1.

Nautilus obesus ?, J. Sowerby *.

The only example of this species known to us which shows any trace of the muscular impression is a cast of a large, crushed, and much broken body-chamber from the Ironstone (Inferior Oolite) of Duston, Northamptonshire (B.M. no. 82328 *b*). This measures 14 inches along the curve of the periphery, the last-formed septum being $4\frac{3}{4}$ inches wide, and the width of the aperture $9\frac{1}{2}$ inches. Fig. 5 has

Fig. 5.



been reduced with the camera from a tracing of the actual impression: *a* indicates the anterior and *p* the posterior boundary; *s* indicates a portion of the last-formed septum. The irregular line on either side of the figure represents merely the broken edge of the umbilicus. Although the specimen is so badly preserved, not only can the anterior boundary of the muscular impressions and annulus be made out, but a portion also of the posterior boundary. On one side of the body-chamber several lines close to and concentric with the anterior boundary of the impression indicate former points of attachment of the anterior edge of the shell-muscle, and may be compared with similar lines to be observed in the shell of the recent *Nautilus* †.

Nautilus clausus, d'Orbigny ‡.

Fig. 6 was traced from a young specimen (2 inches in

* *Ibid.* vol. ii. 1816, p. 51, pl. cxxiv.

† See Geol. Mag. dec. iii. vol. vi. p. 495 (Nov. 1889), fig. E.

‡ 'Paléontologie Française, Terr. Jurassiques,' tom. i. 1842, p. 158, pl. xxxiii.

diameter) of this species from the Inferior Oolite of Caen, Normandy (B.M. no. 37024). The anterior boundary (*a*) of the impression can be distinctly followed from the umbili-

Fig. 6.

cus on the one side across the periphery to the umbilicus on the other side; but no trace exists of the posterior boundary.

The above figures (3–6) show how closely the Jurassic species of *Nautilus* approximate, as regards their muscular attachment, to the recent *Nautilus*; and this analogy may be carried still further back in geological time judging by the figure of a Triassic species (*N. salinarius*) given by Mojsisovics *, in which a considerable portion of the anterior boundary of the shell-muscle is preserved.

We are indebted to the kindness of Dr. H. Woodward, F.R.S., for the use of the woodcuts illustrating this paper.

XXXII.—*Description of a new* Papilio *from the West Coast of Africa.* By H. Grose Smith.

Papilio harpagon.

Male.—Upperside. Both wings blackish brown, with brownish-white spots and bands, as in *P. ucalegon*, Hew., but on the anterior wings the spot towards the end of the cell, and the band, below the median nervure, is broader, and in the middle of the cell is an indistinct brownish-white spot. On posterior wings the band is broader and extends externally as far as the end of the cell.

Underside. Anterior wings as on the upperside. Posterior wings with an orange-coloured spot at the base inside the precostal nervure and another beyond it divided by the costal nervure, followed by three large, indistinct, black spots; a short indistinct streak of orange colour below the median nervure at its base.

Expanse of wings $3\frac{1}{4}$ inches.

Hab. Gaboon.

Very near to *P. ucalegon*, but blacker, with wider bands, and otherwise differing as above described.

In the collections of Mr. Crowley and H. Grose Smith.

* "Die Cephalopoden der Mediterranen Trias-Provinz" (Abh. d. k. k. geol. Reichsanst. Band x.), 1882, pl. xci. fig. 3 *a*.

XXXIII.—*Description of new Species of* Crocidura *from Africa.* By G. E. Dobson, M.A., F.R.S.

The following descriptions of three new species of the genus *Crocidura* are derived from examinations of specimens preserved in the collections of the British Museum, and of the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg. All belong to the section of the genus with twenty-eight teeth. The dentition of each species will be found figured in Part III. of my Monograph of the Insectivora, of which I am about to publish the plates.

Crocidura nana.

Scarcely if at all larger than *Crocidura etrusca*, and therefore the smallest species of this section of the genus as yet discovered. Fur above dark slate-brown, with a faint greyish tinge; beneath white, the colour of the upper separated from that of the lower surface by a sharp line. The feet are clothed with short shining whitish hairs; the tail with short brownish hairs, with many long fine dark brown hairs projecting almost to the tip. Ears moderate, clothed with short dark brown hairs.

The anterior maxillary tooth is shorter than the third incisor in vertical extent, but exceeds it in cross section at the base, and the postero-internal part of its base is in contact with the premolar. (See Monograph of the Insectivora, part iii. fasc. i. pl. xxviii.*) Length, head and body, about 40 millim., tail 30, pes $8\frac{1}{2}$, distance from tip of first upper incisor to apex of principal cusp of last premolar $3\frac{1}{2}$.

Hab. East Africa (Dollo, Somali Land).

Type, the skin of an adult individual, collected by Messrs. F. L. and W. D. James, preserved in the British Museum (Nat. Hist.).

As I am very unwilling to describe new species from skins, I waited for a long time, hoping that a specimen preserved in alcohol might be procured; but my expectations not having been realized I resolved to leave this very interesting species no longer undescribed, particularly as the characters afforded are ample for its recognition.

Crocidura Strauchii.

Slightly larger than *C. aranea*, but with a much longer tail and larger ears. The tail is moderately thick, and clothed with short fur, which nearly conceals all the scales,

* This part of my work will be published in a few weeks.

and between which the long fine hairs project at intervals to within a short distance of the extremity; the muzzle, chin, manus, and pes are well covered with short fur like the under fur on the tail. The ears are apparently naked, being clothed only with very short almost invisible hairs. The fur of the body is short throughout, on the head, back, and upper surface of the tail cinnamon-brown, with bright yellowish-brown extremities, beneath similar, with greyish tips.

The teeth (see Monograph of the Insectivora, part iii. fasc. i. pl. xxvii. figs. 2 & 2 *a*) somewhat resemble those of *C. aranea*, but, besides being altogether larger, they may be at once distinguished, not only from those of that species, but also from those of every other species of this section of the genus, by the form of the anterior maxillary tooth, the base of which develops a horizontal postero-internal process, so that the posterior margin of the base of the tooth is deeply concave.

In the single specimen, an adult male, there is a well-marked lateral gland in the usual position.

Length, head and body, 85 millim., tail 55, eye to tip of nostril 12, ear 10, elbow to end of middle digit (without claw) $18\frac{1}{2}$, manus 8, pes 12, tibia 13, distance of tip of first upper incisor from apex of principal cusp of the last premolar 5.

Hab. N.E. Africa (Soudan).

Type, an adult male, No. 1988, preserved in alcohol in the collection of the Zoological Museum at St. Petersburg.

This species somewhat resembles *C. flavescens* in the colour of the fur, and in the length of the body and tail, but it may be at once distinguished by its smaller size, much shorter pes, forearm, and tibia, by the presence of a well-developed lateral gland, and by the deep concavity in the posterior margin of the anterior maxillary tooth.

I have much pleasure in connecting with this interesting species the name of Dr. Strauch, Director of the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg.

Crocidura macrodon.

In colour and in distribution of the fur like *C. Strauchii*, but with much larger feet, a shorter tail, a much longer muzzle, and altogether larger teeth. The muzzle is remarkably long and pointed, the ears moderate, clothed only with very short hairs, and a few longer ones springing from the margin of the internal folds; the vibrissæ on the sides of the muzzle are fine and very long, the longest extending backwards behind the ears. The fur of the body is short; the tail is clothed with coarse short fur from which long hairs arise; the feet are covered with short hairs of which the longest are at the bases of the claws, which they nearly equal in length.

Both the upper and lower anterior incisors are remarkably long (see Monograph of the Insectivora, pt. iii. fasc. i. pl. xxvii. fig. 3), the upper anterior incisor has a short basal cusp which does not extend even below the cingulum of the second incisor. Viewed laterally the third incisor is very little smaller than the anterior maxillary tooth; but seen from beneath the latter much exceeds the former in cross section at the base, and its cusp very slightly exceeds the anterior basal cusp of the premolar; its base is not emarginate posteriorly as in *C. Strauchii*. The anterior lower incisor has a shallow notch for the posterior basal cusp of the anterior upper incisor.

Length, head and body, 68 millim., tail 46, eye from tip of nostril 14, length of ear $8\frac{1}{2}$, elbow to end of middle digit 19, manus $8\frac{1}{2}$, pes 14, tibia 14, distance of the tip of first incisor from apex of principal cusp of the last premolar $5\frac{1}{2}$.

Type, preserved in alcohol, No. 1968, in the collection of the Zoological Museum at St. Petersburg.

XXXIV.—*On the Constitution of the Body in the* Blattidæ. By E. Haase *.

Any extension of our knowledge of the structure of the Cockroaches, however small, is of special interest, because two characteristic representatives of this family of Orthoptera, the House-cockroach (*Phyllodromia germanica*, Fab.) and the Kitchen-cockroach (*Periplaneta orientalis*, Linn.), from their occurrence in the dwellings of man and their adaptation to this protective habitat, are to be obtained in abundance throughout the year, and further because, on account of their considerable size, they have always served as a chosen material for an introduction to the anatomy of insects.

But, moreover, the oldest remains of fossil insects known to us, the Silurian *Palæoblattina Durvillei*, Brongn. †, and

* Translated from the 'Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin,' Jahrg. 1889, pp. 128–136.

† F. Brauer sees in the preserved remains of the wing indications of a probably synthetic Orthopteron approaching the Mole-Cricket (Ann. k. k. Naturhist. Hofm. Wien, i. 1881, p. 1).

half of all the species known from the Carboniferous formation are to be referred to the Blattidæ.

As the gradual embryogeny of the insect-body distinctly shows, its constitution is to be carried back to the scheme which was drawn up by B. Hatschek * for the origin of the Annelid from the trochophore. But as the structure of the fully-developed insect-embryo is at the same time more sharply defined in its elements than in the case of the Annelida, Myriopoda, and Crustacea, and above all is subject to no variations in the number of its segments, it is desirable to modify somewhat Hatschek's more generally applied denominations of the constituents of the body for the Hexapoda. Thus the expression "frontal piece" may be substituted for Hatschek's "head-segment," as this only forms the head of the insect in conjunction with the jaw-bearing metameres. Further, in consequence of the definitely fixed number of the abdominal segments in the developed embryo of insects, Hatschek's "end-segment" represents no indifferent terminal portion, as it does among Annelida, Crustacea, and many Myriopoda. By the complete suppression in the mature embryo of any indefinite anterior girdle acting as a gemmiparous zone there rather remains only of the terminal segment a terminal section incapable of further development of segments, which, as it bears the anal aperture, may be characterized as the "anal piece."

Consequently the body of the mature embryo of the House-cockroach consists (1) of a frontal piece which bears as a central process the labrum and as lateral appendages the antennary lobes, shows no primitive-vertebriform rudiments of the secondary body-cavity, and is perforated posteriorly by the orifice of the mouth. The originally ventral position of the antennæ, which has been so often cited in evidence of their limb-nature, probably only corresponds to the place of their first origin, and therefore does not carry with it their equivalence to the persistent ventral pedal appendages.

Behind the frontal piece comes (2) the definite number of true metameres, with bilateral, primitive-vertebral foundations of the secondary body-cavity and ventral pedal appendages. Of these segments the first three advance towards the frontal piece and their appendages become jaws; in this way the head of the insect is produced. Behind these follow three thoracic or mesosomatic segments, with the thoracic legs, and finally the abdomen, composed of ten true metameres, the early-indicated embryonic limbs of which soon disappear.

* Arbeit. Zool. Inst. Wien, i. (1878) p. 77.

The abdominal segments are closed (3) lastly by the "anal piece," into which neither the ventral cord nor the secondary body-cavity is continued, and which remarkably resembles the frontal piece. For on the "anal piece" are also two terminal appendages, originally quite ventral and lobiform, like the antennæ, afterwards with tentaculiform terminal appendages, although less developed and later in appearing than the antennæ, *the cerci*, which only subsequently move close to or above the anus.

Further, there is on the anal piece a median dorsal plate above the anus, the anal operculum (*lamina supraanalis*), and generally two anal valves (*valvulæ*) bounding it laterally, to which an inferior opercular piece is but rarely added.

The same number of segments as in *Blatta* occur in all Thysanura, particularly distinctly in *Machilis*, in which the tenth segment still forms a closed ring, while the strongly developed anal piece is distinguished by three long many-jointed appendages, of which the median one represents the anal operculum and the two lateral ones the cerci. In many of the lower insects and their larvæ we also find the same number of segments distinctly marked, as may be best recognized in the Acrydia and other Orthoptera, in the larvæ of Dragon-flies, &c.; even in the larva of *Hydrophilus* R. Heider has demonstrated the occurrence of ten true abdominal segments.

A comprehension of the variable constitution, especially of the abdomen, of the Hexapoda is possible only from the conception of the insect-body founded upon Hatschek's scheme. As will be shown, the divergent conditions can easily be referred back to the primitive condition, such as we have found in the above-mentioned Orthoptera, by citing both the dorsal and the ventral plates of the abdominal segments in simple numbers so far as they are independent and distinctly demonstrable, by furnishing these numbers above with a plus sign (+) when the plates are still distinct in the embryo, but in course of development become so aborted and suppressed that it usually requires special preparations to render them visible, furnishing them above with a minus sign (−) when the plates entirely disappear in the course of the development, and entirely omitting the numbers of those segments which are never formed even in the embryo; and lastly by indicating a secondary amalgamation by a uniting sign ($\frown$) and the anal piece by the letter A, seeing that it is homologous in all forms. As an example how by this schematization an insight into the course of the gradual reduction or amalgamation of the abdominal segments is rendered possible we may also take our Cockroaches.

In the almost completely developed embryo still enveloped in the egg-membranes (without the branchiiform appendages of the first ventral segment) a diminution of the number of the abdominal segments results from the tenth being suppressed, first ventrally and then dorsally, and, as was first demonstrated by Cholodkovsky *, finally having its dorsal plate amalgamated with the anal opercular plate †, when it is still recognizable in the adult male. Subsequently the occurrence of sexual maturity exercises an influence upon the last four segments, inasmuch as the tenth especially appears to be completely aborted in the female. The anterior nine dorsal plates remain in both sexes distinctly developed, rather less so certainly in the females, only the eighth and ninth are retracted somewhat under the seventh dorsal plate. While in the males the nine ventral plates remain developed until maturity, in the females the eighth plate first retreats over the seventh into the body and gradually becomes soft-skinned; then the ninth plate also passes into the body and over the seventh ventral plate; in *Periplaneta* the latter, having the middle of its hinder margin cut off by paired notches, finally grows into a shovel-like process which projects beyond the posterior segment and applies itself to the anal valves ‡. Thus in the mature females probably of all Cockroaches nine dorsal plates, but only the first seven ventral plates, are recognizable. By the retreat of the female sexual aperture, situated in the eighth ventral plate, a considerable space—the genital pouch—is produced; this is formed chiefly by the extended connective membrane between the elongated seventh and the eighth ventral plate. This serves for the development of the egg-cocoon which is retained by the internal appendages of the posterior gonapophyses.

A graphical representation of the divisions of the body of the mature female Cockroach may be furnished by the following number-sketch, in which the numbers standing above the line denote the dorsal and those beneath it the ventral shields of the abdomen §:—

$$\frac{\overline{\mathrm{Fr}+1,\,2,\,3}}{\text{Head}} \qquad \underbrace{1,\,2,\,3}_{\text{Thorax}} \qquad \frac{1\text{—}7,\ \overset{+}{8},\ \overset{+}{9},\ \overset{-}{10}}{1\text{—}7,\ \overset{+}{8},\ \overset{+}{9},\ \overset{-}{10}}\,\mathrm{A};$$

* Zeitschr. f. wiss. Zool. xlviii. (1889) p. 100.

† L. C. Miall and A. Denny ('The Cockroach,' 1886) inaccurately characterize this plate (p. 68 &c.) as the tenth dorsal shield.

‡ These "podical plates" were regarded by Huxley as the terga of an eleventh abdominal segment.

§ Fr indicates the "frontal" and A the "anal piece."

on the other hand the formula for the abdomen of the male of *Phyllodromia*, for example, would be :—

$$\frac{1\text{—}7,\ \overset{+}{8},\ \overset{+}{9},\ \overset{\frown}{10}}{1\text{—}7,\ \overset{+}{8},\ \overset{+}{9},\ \overset{-}{10}}\ \mathrm{A}.$$

The sexual differences extend also to the appendages of the anal piece. Thus in *Periplaneta orientalis* the anal valves of the male are also of a transversely triangular form, but considerably more feebly chitinized than those of the female; in the female of *Phyllodromia* they are similar but still more strongly developed, and they bear at their lower extremity a longitudinally-cleft plate, which is wanting on the soft-skinned, rather globular, anal swellings of the male. The sexual differences of the anal operculum (*lamina supraanalis*) have been long since employed in classification by H. Burmeister and C. Brunner von Wattenwyl.

The movable anal appendages (*cerci*), as already mentioned, resemble the cephalic antennæ in their formation, only they appear later and are less developed. In their structure and possession of sensorial setæ they also agree with the antennæ; nay, from V. Graber's * experiments upon decapitated cockroaches, their function would also seem to consist in the reception of olfactory stimuli. The number of joints in the cerci in the Kitchen-cockroach is 14–16, in the House-cockroach 9–11. In secondarily derived forms with a more globular abdomen the cerci decrease; thus, in the Panesthidæ, for example, in which the female presents only seven distinct dorsal and ventral plates, they appear only as short, inarticulate, triangular appendages. The late development and frequent reduction of the cerci seem to show that they are old inherited appendages which are approaching abortion (through disuse).

On the ninth ventral plate of all embryos and young animals of both the House- and the Kitchen-cockroach short, rigidly setose, unjointed appendages are to be seen which distinctly originate from the ninth segment †. In the female young forms of *Periplaneta* which are still destitute of rudiments of wings these *styles* may be detected even after the retractation of the last ventral plates; they are seated upon

* Biol. Centralbl. Bd. v. p. 452.

† Cholodkovsky (*l. c.* p. 94) ascribes their origin to the tenth segment and supposes them to become converted into the genital hooks of the male; both these views are founded upon errors of observation.

the chitinous plates, which may be recognized as the remains of the ninth ventral plate on each side of the short gonapophysial buds. In mature females (with wing-rudiments) the styles have entirely disappeared; thus they are probably cast off suddenly during a change of skin without being again produced, as no rudiments of them can be recognized.

In the mature males of *Periplaneta*, as in those of most exotic genera, the styles persist distinctly and symmetrically developed.

A want of symmetry in the ninth ventral plate already noticed by Brunner *, probably set up in the males of all forms with the completion of sexual maturity, consisting in a defect of the margin on one side, and an oblique inflection towards the dorsal surface, and probably to be ascribed to the strong development and projection of the long unciform titillator, often causes the reduction, but rarely the complete disappearance, of the styles. Thus in the adult male of the House-cockroach the styles occur only as small knobs, of which the larger left-hand one passes over about in the middle of the ventral plate, which is rendered unsymmetrical by a left-sided emargination; in *Ectobia* the right-hand style disappears entirely. These styles, although noticed by Brunner (*l. c.* p. 129), were entirely overlooked by Brehm † in *Periplaneta*. In many exotic genera the styles are quite rudimentary, as in the above-mentioned *Panesthia*.

The styles are rudimentary in a much greater degree than the cerci, although not such old structures. They occur in the same low grade of development elsewhere only in the males of certain families of the Orthoptera, in Mantidæ, and many Locustidæ, and are, as was first recognized by Wood Mason ‡, perfectly homologous with the abdominal styles which are seated upon the ninth ventral shield of many Thysanura (*Machilis*, *Lepisma*, *Lepismina*, *Nicoletia*), where they assist in the forward movement of the body, and also perform tactile functions; in young Cockroaches also we see them penetrated by strong nerves and muscles which gradually become rudimentary.

In opposition to these styliform appendages in their embryonic development are the gonapophyses, of which it need only be said that they make their appearance in the female only at the retractation of the eighth and ninth ventral plates in the form of processes in the neighbourhood of the sexual

* "Nouveau Système des Blattaires," in Verh. zool.-bot. Ges. in Wien, 1865, p. 15.

† Arb. Russ. Entom. Ges. 1879.

‡ Trans. Ent. Soc. Lond. 1879, p. 181.

aperture. The anterior pair of gonapophyses remains simple and originates on the eighth segment, while the posterior pair forks secondarily and springs from the ninth segment; the position of these gonapophyses therefore corresponds to that ascertained for the above-mentioned Thysanura, as well as the position of the parts of the ovipositor in Grasshoppers and Aculeate Hymenoptera, so that these appendages may probably be regarded as homologous structures.

On the other hand the paired uncinate hooks of the male of *Phyllodromia* appear to originate on the tenth ventral plate, so they should not be regarded as homologous with the developed valves of the penis in *Machilis*, which are seated upon the ninth abdominal ring, but, like the numerous other chitinous pieces around the male genital aperture, only as partial thickenings of the wall. These chitinous projections probably all serve to open and dilate the vagina of the female, especially as a perforated penis, which is highly developed in *Machilis*, seems to be wanting in the Blattidæ.

As Cholodkovsky proved, leg-rudiments perfectly homologous with the thoracic legs are formed in the young embryo from the first to the ninth abdominal segment. Of these embryonic appendages the first pair then become converted into peculiar branchiiform organs (*l. c.* p. 94), which disappear before the exclusion of the embryo; in fact on the first abdominal segment even of older embryos we find only the median ventral shield, which is surrounded by soft, transversely folded connective membrane. On the second to the ninth segments of the same stage the leg-rudiments undergo a plate-like change of form.

On the nearly mature embryo of *Phyllodromia* I find on the isolated ventral surface of the first abdominal segment only the median ventral shield representing the sternal plates of the thorax. On the second segment a median shield which is pretty strongly chitinized at the hinder margin also occurs in the middle, but on each side there is a plate more strongly chitinized, especially towards the lateral margin, but which is also covered with fine wavy wrinkles and short spines. The median ventral shield which is situated above the lateral plates is separated from the latter by delicate longitudinal folds, which may be traced distinctly as far as the seventh abdominal segment.

On the adult animal the tripartition of the ventral plate is distinctly retained only on the second abdominal segment, while the other ventral plates form a single shield on which no trace of longitudinal folds can any longer be recognized. Indications of this constitution of the ventral plates are still to be found in *Periplaneta* and *Blabera* on the second abdominal segment; here the secondary transverse line * is interrupted in the middle, and only an indistinct demarcation of the median shield is to be recognized.

The peculiarities of the formation of the ventral plate above described in *Phyllodromia* are in correspondence with the remarkable condition of the ventral covering of the abdomen of *Machilis*, in which paired duplicatures which may be raised for half their length are united by flat anterior median shields.

Thus we get a fresh proof of the relationship of the Cockroaches with the Thysanura, which at the same time indicates that the ventral plates of the Hexapoda do not represent sternal shields of the same class any more than they correspond to the ventral shields of the Chilopoda, but that they are produced by the amalgamation of paired abdominal leg-rudiments flattened into plates with an unpaired median shield.

XXXV.—*Description of a new Genus of the Homopterous Family* Cicadidæ. By W. L. Distant.

In a collection of Rhynchota made in the Naga Hills by Mr. William Doherty, and which has just reached my hands, I was surprised and delighted to find another gorgeous addition to our knowledge of the Indian Cicadidæ, which again requires fresh generic subdivision. It is allied to the genus *Polyneura*; and as I have already passed that portion of the family in my Monograph, I describe it here and will subsequently figure it in the Appendix to my work.

Angamiana, gen. nov.

Body robust and elongate, broad and somewhat flattened. Head small, including eyes much narrower than pronotum, and narrower than base of mesonotum; ocelli much wider apart from eyes than from each other; face convex, slightly prominent above. Pronotum with the lateral and posterior margins very broad, the lateral margins strongly ampliated and obscurely angulated. Anterior femora distinctly and

* This fine transverse line, which divides the ventral shields of the abdomen into ventral plates and anterior shields, only originates later from the coalescence of delicate transverse wrinkles of the chitinous skin which is still soft.

robustly spined. Tympana covered; opercula broad, obtusely angulated, not reaching the middle of the abdomen. Tegmina with the apical third more or less reticulately veined, the apical areas numerous, generally twelve or thirteen in number.

This genus is allied to *Polyneura*, from which it differs by the much narrower head, the semihyaline and not opaque tegmina, and the different reticulation in the venation of same; the pronotal margin and the size of the opercula are also distinctive characters.

Angamiana ætherea, n. sp.

Body black; eyes castaneous; anterior, lateral, and posterior margins of pronotum (the first narrowly), and an abbreviated, central, narrow, longitudinal fascia to same, posterior margin of metanotum, head beneath (excluding face), sternum, and opercula pale greenish ochraceous; legs and rostrum black. Body more or less clothed with greyish pile, especially at the lateral margins of the mesonotum and the base and segmental margins of the abdomen.

Tegmina semihyaline and of a pale shining bronzy hue, the venation darker and either ochraceous or greenish, the costal membrane pale greenish; the extreme base and the veins enclosing the postcostal area black; the veins enclosing the two uppermost apical areas, the terminal vein of the lower ulnar area, and the outer margin dark bronzy. Wings pale bluish green, becoming pale bronzy towards apex, the outer margin dark bronzy.

The opercula are broad and divergent, their outer margins convex, their inner margins oblique, their apices obtusely angulated and not reaching the middle of the abdomen. The rostrum about reaches the posterior coxæ.

Long. excl. tegm., ♂ 46, ♀ 40–42 millim.; exp. tegm. ♂ ♀ 124–132 millim.

Hab. Continental India, Naga Hills (*Doherty*).

XXXVI.—*Diagnosis of a new* Cynopterus *from Borneo.* By Oldfield Thomas.

Cynopterus spadiceus, sp. n.

Closely allied to *C. latidens*, Dobs., with which it shares the characteristic structure of the teeth, but distinguished by its larger size, much shorter fur, especially on the under surface of the body, the presence of tufts of coarse yellow hairs on the sides of the neck, and by the entire nakedness of the throat, wing and interfemoral membranes, and limbs. The hind legs especially in *C. latidens* are clothed above to the ankles, while in *C. spadiceus* they are wholly naked. Colour dark rufous brown above and on the sides below, paler on the neck and along the centre of the belly.

Skull and dentition much as in the allied species, except that the anterior premolars are deciduous, being absent in the type; the molar teeth above are larger and heavier, those below are rather longer but not quite so broad, and the last lower molar is slightly larger. The incisors number $\frac{4}{4}$ and are subequal in size, the inner ones above being very slightly longer than, but of the same thickness as, the outer.

Measurements of the type, an adult female, preserved as a skin :—

Head and body (stretched) 130 millim. ; forearm 77 (=3·05 in.) ; thumb, including claw, 25 ; lower leg 27.

Skull.—Greatest breadth 25; palate, length 19; front of canine to back of last molar, above 13·6, below 15·7; $\frac{m.\,1}{}$ 3·0 × 2·8, $\frac{m.\,2}{}$ 2·5 × 2 3; $\frac{}{m.\,1}$ 3·0 × 2·9, $\frac{}{m.\,2}$ 2 7 × 2·6.

Hab. Baram, N.W. Borneo. Collected by Mr. Charles Hose.

XXXVII.—*Report upon a small Collection of Scorpions and Centipedes sent from Madras by Mr. Edgar Thurston, of the Government Central Museum.* By R. I. POCOCK, of the British Museum (Natural History).

[Plate XII.]

SCORPIONIDEA.

THE Scorpions sent by Mr. Thurston are referable to four species, whereof one is new. The series of the species *Sc. Swammerdami* has been most useful in showing the amount of variation presented during the passage from the young to the adult condition.

Isometrus maculatus (De Geer).

This species is cosmopolitan.

Buthus Martensii, Karsch.

Buthus Martensii, Karsch, Mitth. Münchn. ent. Ver. 1879, p. 112, ♂; Pocock, Ann. & Mag. Nat. Hist. 1889, iii. p. 335, pl. xv., ♂ ♀.
Buthus grammurus, Thorell, Ann. Mus. Genov. 1889, pp. 567–570, ♀, pl. v. fig. 4.

This species has been recorded from so many widely separated localities in India that it is not rash to surmise that it exists all over the country. The British Museum has specimens from Sikkim, Umballah, Bengal, Madras, and Bombay. All the specimens possess the black lines on the tail which Thorell states to be characteristic of *grammurus*, and a feature by which it may be separated from *hottentotta*. This, however, is not the case, for nearly all the specimens of *hottentotta* in the British Museum have black-lined tails.

Scorpio Swammerdami (Simon) *.

Heterometrus Swammerdami, Simon, Rev. Mag. Zool. 1872, p. 56, pl. vi. fig. 3.
Pandinus asper, Thorell, Etudes Scorpiol. pp. 125–128 (1876).
Pandinus Kochii (Peters, MS.), Karsch, Mitth. Münchn. ent. Ver. 1879, p. 127.
Scorpio lucidipes, Simon, Bull. Soc. Zool. Fr. x. p. 38 (1885).

This Scorpion is the largest of the Indian species and one that is very easily recognized in the adult condition; the cephalothorax is much depressed laterally and posteriorly, the inner border of the hand is straight, and the tail is long and powerful.

Four species presenting these characters have been described—two by Mons. Simon, one by Dr. Thorell, and one by Dr. Karsch. But the examination of a long series of forms, such as exists in the British Museum, shows that the characters of these so-called species are not constant and that they vary with age, sex, and individuals. This is clearly shown by the appended table of measurements of some of the Museum specimens. Included in the table are many of the examples sent by Mr. Thurston from Madras, and these specimens, being immature and adult examples of both sexes, have proved most useful in establishing the above-given synonymy.

Of *Sc. asper* Dr. Thorell says:—" *P. Swammerdami* (Sim.) valde affinis est *P. asper*; forma manuum in utraque specie eadem, sed *P. Swammerdami* major est, obscurior,

* All must agree with Dr. Thorell that if the name *Aranea* be abolished as a generic term the name *Scorpio* must be treated in a similar fashion. But the principle upon which this system rests, if widely extended—and consistency demands that if it be applied to one case it be extended to all—would lead to the abolition of many names which are now in common use. Thus *Papilio, Musca, Vespertilio, Anguis*, &c. would have to be abandoned, and much confusion would thereby be occasioned. Consequently it were surely better that these terms, which were originally used in a general sense, be retained as restricted by zoologists of the present day.

minusque scaber, et granula in superficie superiore manuum ejus majora sunt, humilia et rotundata, cephalothorax multo brevior quam segmenta caudæ $1^m + 2^m$, cauda circiter $4\frac{1}{3}$ longior quam cephalothorax, vesica latior quam segm. caudæ 5^m, parum longior quam latior, aculei longitudo vesicæ latitudine minor."

However, in specimens of *Swammerdami* the colour of the trunk varies from reddish brown to dark green; the degree of granulation also varies considerably, in smaller specimens the granules upon the hands are relatively coarser and much more defined than in larger specimens, in which they appear to have been worn away and fused together; the length of the tail increases with the size of specimens and varies with sex, being considerably longer in the adult male than in the adult female. In young specimens the cephalothorax equals in length the length of the first two caudal segments taken together; in the adult female it is shorter and in the adult male very much shorter; the width of the vesicle also increases with age; in small specimens it is as wide as the fifth caudal segment, in large specimens it is much wider.

So far, then, the differences between *asper* and *Swammerdami* may be accounted for on the supposition that *asper* is merely an immature specimen. But on glancing over the table of measurements given by Dr. Thorell of his type, there may be noticed some curious facts which seem at first irreconcilable with the view of the specific identity between *Swammerdami* and *asper*. The following measurements are given in millimetres:—Total length 97, cephalothorax $15\frac{1}{2}$, tail 60, first two caudal segments $16\frac{3}{4}$, fifth caudal 13, width of vesicle 5; manus, length $15\frac{1}{2}$, width $12\frac{1}{4}$.

Now, if the accompanying table of measurements be examined, it will at once be seen that specimen N is almost of the same length as the type of *asper*, and therefore, unless the two be different species, the other measurements should coincide approximately. But this is certainly not the case, the measurements of *asper* being enormously greater in each instance. But no doubt the explanation of this discrepancy is that the type of *asper* being dry, the segments of the abdomen, as is often the case, have become drawn together by the shrinking of the arthrodial membrane, so that the first overlaps the second, the second the third, and so on. Now specimen N is preserved in spirit and the tergites and sternites of the abdomen are perfectly distinct. But if it be allowed that the shrinkage in the type of *asper* amounts to a little more than 2 millimetres for each abdominal segment, we may roughly put the original length of the specimen at about 115 or 116 millimetres. If, then, it be compared with specimen G in the list, which is $115\frac{1}{2}$ millim. in total length, it will be found that the other figures agree remarkably well, the only exception being that the length of the tail in *asper* is far too little, being 60 as opposed to 63. But if we take the measurement as given by Dr. Thorell of each caudal segment separately, we find that the total amounts to $61\frac{3}{4}$. Thus only a slight difference is left, and this needs no accounting for if it be remembered that 63 represents the length of the segments *plus* the arthrodial membrane, whereas $61\frac{3}{4}$ is the length *minus* this membrane. The type of *asper*, then, appears to be a young male of *Swammerdami*.

Dr. Karsch describes his species as follows:—"*Pandinus Kochii* (Peters, MS.), quam formam a *Pandino Swammerdami* (E. S.) differre nullo modo possum quam magnitudine minore, ca. 105, in *Swammerdami* 158 mm.; sed Thorell cephalothoracem hujus speciei caudæ segmentis $1^{\circ}+2^{\circ}$ conjunctim multo breviorem descripsit, qui in nostra forma in duobus exemplis siccatis ex Java segmenta $1^{m}+2^{m}$ caudæ anteriora longitudine omnino æquat et ad *P. asprum*, Thor., speciem minorem long. ca. 97 mm. cadere non potest, quum Thorell ejus cephalothoracem segmentis caudæ $1^{\circ}+2^{\circ}$ conj. parum breviorem describeret et species nostra *P. Swammerdami* nec *P. aspri* sculpturam ostendat."

It is clear from what is written above that at the time Dr. Karsch had not seen a specimen of *S. Swammerdami*; consequently the statement about the sculpture of his species must be treated with caution. For the rest, the difference in the length of the first two caudal segments observed between *Swammerdami*, *asper*, and *Kochii* is, as we have shown, a character dependent upon age and sex. For instance, in specimen N in our table—a young female—the cephalothorax equals in length the first two caudal segments. I believe therefore that the types of *Kochii* are young females of *Swammerdami*. It must be admitted, however, that an element of doubt on this point exists on the strength of Java being assigned as the locality for the species.

Mons. E. Simon separates *lucidipes* from *Swammerdami* for the following reasons:—the size is smaller, the legs are bright yellow, the hand is much smoother and a little wider than long (in *Swammerdami* it is exactly as wide as long), the fifth caudal segment is the same length as the cephalothorax (a little longer in *Swammerdami*), of the same width as the vesicle, and strongly channelled above in its upper half (a little narrower than the vesicle and scarcely channelled in *Swammerdami*). But each of these as a specific character may be taken exception to. Size by itself is of course valueless; the colour of the legs, as shown by the Museum series, varies from very dark brown to clear pale yellow —thus in specimen J they are very deep brown, in A light brown, in F dark yellow, in M pale yellow; the fifth caudal segment is shorter than the cephalothorax in females, as long in males of a certain age, and longer in large males; and the vesicle, as stated above, is wider than the fifth caudal segment in adults and of the same width in young forms; the groove on the upper surface of the vesicle varies from being invisible to clearly pronounced; the sculpturing of the hand is also a matter of individual variation.

The only character that seems of importance is the width of the hand, for in *lucidipes* it is stated that the hand is wider than it is long. Now, a glance at our table of measurements shows that, although subject to variation, the length of the hand is always greater than the width; so that when, in addition to the statement about *lucidipes*, it is noticed that Mons. Simon asserts that in *Swammerdami* the width of the hand is as great as the length, the conclusion seems almost inevitable that his measurements have been taken along different lines from those in the table. In the table the greatest width is taken along a line at right angles to the axis of the brachium, and the greatest length from a point on the anterior (inner) surface at the base of the dactylar prolongation to the extremity of the dilatation of the hand. And this measurement of the length always exceeds that of the width. If, however, the width be taken from the point of articulation of the movable dactylus to the extremity of the dilatation, it will be found to be as great or greater than the length.

That this explanation is the true one is rendered practically certain by the fact that in the figure of the type of *Sc. Swammerdami* the form of the hand is the same as in the specimens in the Museum collection, and that when measured as these have been measured the length is always greater than the width.

Sufficient grounds have now, I think, been found in each case to justify the conclusion respecting the specific identity of the forms that have received the above names.

Table to show the amount of Variation presented by Sc. Swammerdami.

Specimen.	Mode of preservation.	Sex.	Total length.	Tail, length.	Cephalothorax, length.	1st two tail-segments, length.	5th tail-segment, length.	5th tail-segment, width.	Vesicle, width.	Manus, width.	Manus, length.	Locality.
			millim.	millim.	millim.	millim.	millim.	millim.	millim.	millim.	millim.	
A ..	In spirit.	♂	176	98	20	27·3	21	8	9	21	24	Ceylon.
B ..	”	”	140	82	18	23	18	7	7	17	18	”
C ..	Dry.	”	131	81	18	22	18	7	8	17	19	Madras.
D ..	”	”	127	80	17	21	17	7	8	17	18·5	Burdwan.
E ..	”	”	119	68	15·5	17·1	15	6	7	13	16	”
F ..	In spirit.	”	Trunk distorted.	76	16·5	20	17	7·3	7	17·5	18	India.
G ..	”	”	115·5	63	15·5	16·5	13·5	5·3	5	12·7	15	Madras.
H ..	”	”	91	49	12·5	13	10	3·5	3·5	9	11	”
I....	”	?	75	39	10·5	10·5	8	3	3	6	9	”
J....	”	♀	166	95	21	25	20·5	8·3	9	20·5	23·5	”
K ..	Dry.	”	151·5	89	21	23	19·5	8	9	20	22·5	India.
L ..	”	”	146	84	20	24	19	7	8	18·5	22	”
M ..	In spirit.	”	140	80	19·3	21	17·5	7	8	19·5	21	Coonoor.
N ..	”	”	96	51	13·5	13·5	11	4	4	10	12	Madras.

Hormurus læviceps, sp. n. (Pl. XII. figs. 1 and 1 *a*.)

Colour of upper surface of trunk varying from ochraceous to piceous, under surface always much paler, testaceous or ochraceous; palpi and legs reddish brown to almost black above, paler beneath; vesicle always much paler than the rest of the tail, usually streaked beneath with darker bands of colour; aculeus dark brown.

Cephalothorax closely and finely punctured throughout, almost wholly smooth, sometimes very slightly and finely granular in its postero-lateral portions, marked here and there, especially on its margin, with setiferous pores; marked throughout its extent by a median longitudinal sulcus; its anterior margin somewhat shallowly excised; the area around the median eyes flat or slightly depressed; the median eyes of relatively small size and not elevated on to a tubercle.

Tergites very finely and closely punctured, smooth or feebly granular at the sides, the punctures very numerous and fine on the hinder margin; the third, fourth, fifth, and sixth marked with two conspicuous depressions, which define a more or less pyriform area; these depressions only faintly developed on the first, second, and seventh tergites.

Sternites marked with two abbreviated subparallel depressions, very faintly and closely punctured.

Tail.—Lower surface thickly and closely punctured, the first four segments not keeled below, the lines of the keels being marked by serially arranged setiferous pores, the fifth segment with its inferior keels marked by three rows of unevenly spaced granules; upper surface of the tail without keels; the anterior segments very slightly granular at the sides; the posterior segments smooth throughout; the median sulcus perfectly smooth; vesicle pyriform, flatter and lightly sulcate above, smooth and setose beneath; aculeus short and abruptly curved.

Palp.—*Humerus* with upper surface thickly and finely punctured, and either, at all events in its proximal half, thickly and finely granular, or almost wholly smooth, its anterior surface finely and sparsely granular and bounded above and below by a series of stronger sharp tubercles; its inferior surface finely and closely punctured, smooth; the posterior surface somewhat coarsely granular above. *Brachium* with upper surface smooth and punctured, posterior surface feebly granular and defined above and below by a subtuberculate ridge; inferior surface smooth and punctured; anterior surface smooth or slightly granular proximally, defined below by a series of conspicuous denticles and above by a subtubercular or subgranular ridge, the basal prominence armed with two larger and sometimes a few smaller teeth, each of the larger teeth bearing a setiferous pore. *Hand* thickly punctured above, smooth or subrugulose, distinctly though sparsely granular in front, smooth below and somewhat coarsely granular behind, the "hand-back" defined above and below by a conspicuous subgranular keel. Movable dactylus slightly or considerably shorter than the "hand-back," with a feebly developed lobe at the distal end of the inner surface; when the dactyli are closed a corresponding but less well developed lobe on the immovable dactylus fits in front of that on the movable dactylus.

Femora of the first three pairs of legs furnished beneath with a posterior long and an anterior short series of granules; *femora* of the fourth pair granular beneath only at the distal extremity.

Pectines with, as a rule, five teeth, rarely four or six, and in one instance only three.

Stigmata slit-like.

The *genital operculum* in the female without trace of median suture, the right and left halves having coalesced to form a plate, very much wider than long, with angularly produced posterior margin.

Measurements in millimetres of a ♂ specimen.—Total length 55; cephalothorax, length 8, width 8·5; tail, length 25—first segment 3, second segment 3·5 (taken together 7), fifth segment 5·4; vesicle and aculeus, length 6; humerus, length 7; brachium, length 7·5; "hand-back," length 9; width of hand 5·5; movable dactylus, length 7.

A number of specimens of various ages and both sexes.

This species is closely allied to *H. caudicula*, L. Koch, a species found in the Australian and Austro-Malayan region. *H. læviceps*, however, may be recognized by being almost wholly smooth (*H. caudicula* having distinctly sculptured tergites and coarsely granular cephalothorax and palpi), in having the median eyes much smaller and not situated on an eminence, in having the form of the dactyli the same in the two sexes, and in having the genital operculum in the female of a different shape (in *caudicula* this plate bears distinct traces of the median suture, is more heart-like in shape, less angularly produced behind, and less wide relatively to its length); moreover, the ridge which forms the upper boundary to the "hand-back" is more strongly developed.

In addition to the series sent by Mr. Thurston from Madras the British Museum possesses two specimens (♂ ♀) sent by Mr. W. Davidson from the Anamallai Hills, Koimbatur. These appear to differ slightly from the Madras form in being a little more granular, in having a slightly longer tail, and in having the anterior margin of the cephalothorax a little more deeply excised.

This species also presents strong points of resemblance with *H. diremptus*, Karsch—the only species of the genus known from Africa—but, according to the description, the cephalothorax of *diremptus* is a little longer than the "hand-back," whereas in *læviceps* it is always shorter; moreover, the movable finger of *diremptus* bears near the middle of its inner surface a large lobe and the fingers are widely separated at the base when closed (in *læviceps* they are in contact throughout their length).

Chilopoda.

Only a few species of this group were obtained, yet more than half of them prove to be new. Of these one is a species of *Himantarium* and the others are species of *Otostigma*. It seems at first a surprising fact that out of the four species of *Otostigma* in the collection all should be new to science; but it is not a matter for wonder in the face of the circumstance that, although this genus is richer in species in the Oriental Region than any other (with the exception perhaps of *Scolopendra*), yet until now only one species, and that a widely distributed one, has been recorded from India proper!

In fact, the knowledge that we possess of Indian Myriopoda—and the same almost may be said with respect to Spiders and Scorpions—is ridiculously scanty considering the length of time that the country has been occupied by the English. Judging by analogy, these animals must be exceedingly abundant, and an enormous number of new forms could doubtless be collected by anyone who would but take the trouble to look for them.

Scutigera longicornis (Fabr.).

A very widely ranging species. Common in India and Burma, and extending through Sumatra and Borneo.

Genus Rhysida.

Rhysida, Wood, Journ. Ac. Sci. Philad. v. p. 40 (1863).

This name was put forward by Dr. Wood to take the place of *Branchiostoma* of Newport, *Branchiostoma* having been previously applied by Costa to the genus which is commonly known as *Amphioxus*. But Dr. Wood's proposal has met with no acceptance. Nevertheless, in accordance with the laws of nomenclature, his name *Rhysida* must be adopted for those centipedes which, since Newport's days, have been termed *Branchiostoma*.

Rhysida immarginata (Porath).

Branchiostoma immarginatum, Porath, Bih. Sv. Vet.-Ak. Handl. iv. p. 24 (1876).

Common in Further India, but never before recorded from India proper.

Heterostoma spinosum, Newport.

Hitherto known only from Ceylon.

Otostigma splendens, sp. n.

Colour mostly ochraceous, but shining with metallic lustre.

Head-plate not narrowed behind, a little wider than long, not sulcate.

Antennæ short, composed of seventeen segments, whereof the basal two are naked and the rest pubescent.

Maxillary sternite convex from before backwards and from side to side; prosternal plates short, armed with four sharp teeth; basal tooth bidentate; claw stout and short.

Tergites from the fifth strongly bisulcate, from the eighth marginate, from the sixth faintly wrinkled laterally, and in the posterior half of the body obsoletely grooved between the sulci.

Sternites marked with two very abbreviated sulci in front and with two median impressions, one central, the other posterior.

Anal somite.—*Sternite* with straight converging sides and lightly concave hinder margin; *pleuræ* covered with small pores, the process slender, short, armed apically with two strong spines and above with one strong spine; *legs* moderately long; femur armed with six spines, one in the middle of the upper inner margin, two on the under inner margin, and three on the under outer margin; tarsus unarmed, claw-spined; *tergite* not impressed behind.

Legs.—Tarsal segment of the preanal legs unarmed; proximal tarsal segment of the rest of the legs armed with a single spur.

Three specimens, length 50 millim.

This species is undoubtedly very closely allied to *O. ceylonicum*, Haase, but it appears to be very much less wrinkled;

moreover, in *ceylonicum* the tarsus of the preanal leg is armed with a spur, the pleuræ terminate in a single spine, and the anal tergite has a different form.

Otostigma morsitans, sp. n.

Colour olivaceous, legs and under surface paler, not or hardly metallic.

Head-plate wider than long, not narrowed behind and not sulcate, sparsely but somewhat deeply punctured.

Antennæ short, composed of seventeen segments, whereof the basal two are naked and the rest pubescent.

Maxillary sternite punctured like the head, prosternal plates short, in contact, and obscurely divided into four teeth; basal tooth of the maxillipedes bearing two feebly developed teeth.

Tergites very finely and closely punctured and also furnished with larger and more scattered punctures; from the sixth bisulcate, from the eighth marginate, and from the fifth wrinkled laterally; in the posterior half of the body the tergites are wrinkled also in the centre and those in about the hindmost third of the body are armed with many irregularly arranged spicules.

Sternites punctured like the tergites, not bisulcate, but furnished with two impressions on each side of the middle line in the centre of the plate and a much fainter impression in the middle of its posterior border.

Anal somite.—*Sternite* with nearly straight converging sides and very lightly concave hinder margin; *pleuræ* thickly and finely punctured, bearing a single well-developed spine in the middle of the posterior edge, the process very short and armed with two apical spines; legs moderately long and slender, tarsus unspined, femur armed with only five spines, situated on the under surface—two of these form an internal and three an external series; *tergite* bearing a median keel in its anterior half, scarcely impressed behind.

Legs.—Proximal tarsal segment of all the legs, including the preanal pair, armed with a single inferior spur and sometimes also with an anterior spine.

Length of largest specimen 61 millim.

This species is also closely allied to *O. ceylonicum*. It differs, however, in having a very short pleural process terminated by two spines and in having the spines on the anal femora confined to the under surface. In having the posterior tergites covered with spicules it resembles *O. carinatum*, but with this species it cannot be confounded.

Otostigma nudum, sp. n. (Pl. XII. figs. 3–3 *b*.)

Colour of tergites pale olivaceous, of sternites testaceous, of head, first tergite, and maxillary sternite rufous, tarsi with pale green tint.

Head-plate ovate, long, longer than wide, not sulcate.

Antennæ short, composed of seventeen segments, whereof the proximal three are naked and the rest pubescent.

Maxillary sternite relatively long, sparsely punctured, and marked with a shallow, median, longitudinal sulcus; prosternal plates long and produced far forwards, so that the anterior edge is almost on a level with the apex of the basal tooth of the maxillipede, the two almost in contact and each armed with four poorly developed teeth; the basal tooth of the maxillipede sharp and bearing on its inner side a small tooth; claw stout and curved.

Tergites very minutely and closely punctured; from the fifth bisulcate, from the eighth marginate, those in the middle and posterior half of the body wrinkled laterally and in the middle.

Sternites conspicuously trisulcate, being marked with the usual lateral sulci and, in addition, with a median, longitudinal, more or less abbreviated sulcus.

Anal somite.—Sternite with posteriorly converging lateral margins and lightly concave posterior margin; *pleuræ* covered with relatively large pores, the process short, stout, slightly incurved, and terminated by two spines, not armed with lateral or superior spines; *tergite* not sulcate and not posteriorly impressed; *legs* short and stout, femur armed with seven spines—two on the upper-inner edge, two on the under-inner edge, and three on the under-outer edge; upper surface of femur, patella, and tibia obsoletely and longitudinally sulcate; tarsus not armed with spur, claw furnished with two basal spines.

Legs with tarsal segments *unarmed*; claws spined.

Length of body 52 millim.

In possessing trisulcate sternites, larger pleural pores, and forwardly-produced prosternal plates this species is allied to *O. geophilinum*, Haase; but it differs markedly from all the Old-World species of the genus known to me in having the tarsal segments of all the legs unspined.

A single specimen only was sent.

Otostigma ruficeps, sp. n. (Pl. XII. figs. 2–2 *b*.)

Colour of tergites somewhat grass-green, legs and sternites paler; head-plate, with exception of the frontal area, which is green, and first tergite, castaneous ; antennæ green; maxillary sternite castaneous, with the exception of its anterior third, which is pale green.

Head-plate truncate behind, wider than long, not sulcate.

Antennæ relatively long, composed of twenty-one elongate segments, whereof the basal two are naked and the rest pubescent.

Maxillary sternite wide, distinctly hollowed in its lateral portions, the concavity being bounded behind and at the sides by a well-marked ridge; prosternal plates divergent from the base, each armed with four strong and sharp teeth ; basal tooth of the maxillipedes projecting far in advance of the prosternal plates, each distinctly bi- or tridentate ; claw long and slender.

Tergites from the seventh sulcate, from the tenth marginate, obsoletely wrinkled.

Sternites not sulcate, at most bearing the very faintest indications of two lateral impressions.

Anal somite.—Sternite with very convex lateral margins and strongly concave posterior margin ; *pleuræ* thickly covered with small pores, the process short and stout, terminated by one or two small spines, without superior or lateral spines ; *tergite* with a faintly marked posterior impression ; (anal legs absent).

Legs with the claws armed with two basal spines ; the proximal tarsal segment armed with two spurs, an anterior and an inferior ; in addition the patella of the first pair of legs armed with a single anterior spine, and the tibia of the first seven pairs armed with a single anterior spine.

A single specimen, length 41 millim.

In the absence of the anal and preanal legs it is not possible to point out the affinities of this species. But it is sufficiently characterized by the depressed condition of the sides of the maxillary sternite—a peculiarity which I have never seen in any other member of the genus.

Himantarium (?) *striatum*, sp. n. (Pl. XII. figs. 4–4 *b*.)

Colour ochraceous, with darker markings and a pale median band above, paler beneath.

Head-plate scarcely longer than wide, convex, anterior and lateral margins convex, with rounded postero-lateral angles and straight posterior margin, completely covering the maxillary feet ; frontal lamina large and distinct.

Basal plate as wide as the head, very short, being about five times as wide as long.

Maxillary sternite very wide, twice as wide as long, marked by a deep and wide sulcus, which runs longitudinally from the middle of the anterior border to the middle of the posterior border; maxillipedes almost reaching the anterior border of the cephalic plate, the claw enormously long, lightly curved, and blade-like.

Antennæ not attenuate, of a uniform thickness throughout, the apical segment as long as the two that precede it; shortly hirsute.

Tergites not bisulcate, but conspicuously although finely striate.

Sternites marked with a median circular porous area and behind the middle with a transverse porous area, which in the middle and hinder half of the body becomes divided into two halves.

Anal somite.—Tergite not covering the pleuræ; *pleuræ* moderately inflated, furnished with many close-set pores where they come in contact with the anal tergite and sternite, and a few scattered but conspicuous pores on the disk; *sternite* parallel-sided, with rounded postero-lateral angles and straight posterior margin, its surface marked with a median longitudinal sulcus; anal legs very short, considerably shorter than the preceding pair, composed of five segments and terminated by a claw.

Number of pairs of legs (♀) 69; length 38 millim.

A single specimen.

This species has been only provisionally referred to the genus *Himantarium*; lack of material has prevented me from putting the specimen to a critical examination sufficiently exact to determine its generic position. It is undoubtedly congeneric with Dr. Meinert's *Himantarium insigne* and *indicum* (two species from Kooloo), but it differs from both in having its pleuræ distinctly porous and its anal legs armed with a claw.

Mecistocephalus punctifrons, Newport.

Common throughout the Oriental Region.

EXPLANATION OF PLATE XII.

Fig. 1. *Hormurus læviceps*, sp. n., ♂, nat. size.
Fig. 1 *a*. Ditto, ♀. Sternum, operculum, and pectines.
Fig. 2. *Otostigma ruficeps*, sp. n. Head from above.
Fig. 2 *a*. Ditto. Head from below.
Fig. 2 *b*. Ditto. Anal pleura from the side.
Fig. 3. *Otostigma nudum*, sp. n. Head from above.

Fig. 3 *a.* *Otostigma nudum*, sp. n. Head from below.
Fig. 3 *b.* Ditto. Anal somite from below.
Fig. 4. *Himantarium* (?) *striatum*, sp. n. Head from above.
Fig. 4 *a.* Ditto. Head from below.
Fig. 4 *b.* Ditto. Anal somite from below.

XXXVIII.—*Description of a new Genus and Species of Scorpion belonging to the Group* Jurini. By R. I. Pocock, of the British Museum (Nat. Hist.).

[Plate XI. B, figs. 1–1 *c.*]

Uromachus, gen. nov.

Sternum pentagonal, longer than wide.

Movable and immovable dactyli of the cheliceræ armed with three strong teeth above, and with a series of similar tubercular teeth below.

Hands distinctly costate.

Cephalothorax with anterior margin truncate; ocular tubercle not divided.

Stigmata circular.

Vesicle of tail elongate, about as long as the fifth segment, almost parallel-sided, not globular; slender at its anterior end, flattened beneath; aculeus very short, about one fifth of the length of the vesicle, stout in its anterior half, its posterior half becoming abruptly spiniform.

This genus is closely allied to *Chœrilus* of Simon, and may only be separated from it by the remarkable form of the caudal vesicle. The vesicle is somewhat elongate in *Chœrilus*, but in this new species it is so totally different in shape from that of any other Scorpion, that I have thought the peculiarity worthy of generic distinction. Is it a sexual character?

Uromachus pictus, sp. n. (Pl. XI. B, figs. 1–1 *c.*)

Colour reddish brown, variegated with black.

Cephalothorax.—Anterior border almost straight, very slightly emarginate; the sides abruptly sloped at an angle from the median portion; the ante-ocular area nearly flat, slightly hollowed anteriorly and smooth, the post-ocular area deeply marked by the median sulcus, which is continuous in front with a hollow on each side of the ocular tubercle, the sides of the sulcus distinctly granular; the tubercle situated well in the anterior half of the cephalothorax, not sulcate but prolonged in front and behind into a short tapering process;

the lateral portions of the cephalothorax somewhat coarsely granular; two contiguous lateral eyes on each side.

Tergites sparsely and bluntly, but somewhat coarsely granular; the third, fourth, fifth, and sixth with a median low smooth keel in front, and one low smooth keel on each side, the seventh bearing on each side above a low eminence terminating behind in a tubercle, and below a subtubercular keel which also terminates behind in a large tubercle.

Sternites smooth, anteriorly bisulcate.

Tail more than five times as long as the cephalothorax, tapering gradually from the base to the posterior end of the fifth segment; the segments above excavated only in front and close to the joint; the rest of the upper surface flat, or nearly so; the first segment provided with ten keels, the second, third, and fourth with eight keels, the fifth with seven keels; the superior keels on the first four well expressed and denticulate in the posterior half; the superior lateral keels more prominent and complete on these same segments, but less denticulate than the superior keels; the rest of the keels almost smooth, more or less uneven and subtubercular on the first three segments, but on the fourth they are distinctly but irregularly and bluntly dentate; in the fifth segment the superior keels are almost absent, being represented merely by the edge formed by the slope of the lateral surface at right angles to the upper surface, this edge is sparsely and bluntly dentate, the superior lateral keels are well expressed and bluntly and sparsely dentate; the three inferior keels more strongly developed than in the preceding segments, and strongly and sparsely dentate; the upper surface of this segment anteriorly obsoletely bicostate. *Vesicle.*—Upper surface nearly flat and smooth in front, in its posterior two thirds convex from side to side, and thickly and coarsely granular; beneath it is flat or slightly concave, and, as also are the sides, coarsely but bluntly granular; its greatest width is less than one third of its length, and its greatest height or thickness less than one fourth of its length; anterior half of the aculeus subtubercular below, the posterior half spiniform but short, and but little curved.

Palpi: *humerus* with upper surface sparsely but coarsely granular, and bounded in front and behind by a low, bluntly subdentate keel; the anterior surface somewhat strongly tubercular and granular; the posterior surface smooth. *Brachium* distinctly carinate above, behind, and below, the keels smooth or subtubercular. *Manus* dilated, furnished with ten complete, mostly granular or subtubercular, strong keels, the superior internal keel dentate; the intercarinal spaces granular and adorned with a reticulated pattern formed of rows of minute granules; *dactyli* short and strong, in contact throughout, neither sinuate, lobate, nor strongly dentate, but armed with a number of oblique, subparallel rows of denticles, the apical denticles of each row being the largest.

Legs with femora anteriorly granular.

Pectines furnished with five large teeth.

Measurements in millimetres.—Total length 62; cephalothorax, length and width 7; distance of central eyes from post-marginal 4: tail, length 41·5—first segment, length 4, width 3·2; second, length 5·2, width 2·8; third, length 5·8, width 2·8; fourth, length 6·3, width 2·8; fifth, length 10, width 2·3: vesicle, length 9·7, greatest width 2·5, at base 1·7, height 2; aculeus, length 2; palpi, humerus, length 5·5; brachium, length 6; manus, width 4, length 6·7, height 4; length of "hand-back" 6; movable digit, length 6.

Two dried specimens in the Museum, apparently adult, but of doubtful sex, from Silhet. One of these, which I have selected as the type, was from the collection of Mr. Stainsforth.

EXPLANATION OF PLATE XI. B, Figs. 1–1 *c*.

Fig. 1. *Uromachus pictus*, gen. et sp. nov., nat. size.
Fig. 1 *a*. Ditto. Fifth caudal segment and vesicle from the side.
Fig. 1 *b*. Ditto. Aculeus from the side.
Fig. 1 *c*. Ditto. Aculeus from below.

BIBLIOGRAPHICAL NOTICES.

A Monograph of Oriental Cicadidæ. By W. L. Distant. Published by order of the Trustees of the Indian Museum, Calcutta.—Part 1. 4to. London: King & Co., 1889.

A Catalogue of the Mantodea, with descriptions of new Genera and Species, and an Enumeration of the Specimens in the Collection of the Indian Museum, Calcutta. By J. Wood-Mason.—No. 1. 8vo. Calcutta, 1889.

In some recent notices of Manuals of Indian Vertebrate Animals issued under Government auspices, we ventured to express a hope that on the completion of the proposed series of works it might be found possible to treat the rich invertebrate fauna more or less in the same fashion. We have now to notice the commencement of two works which would seem more or less to tend towards this desideratum, although they do not, in many respects, take a position parallel to that of the other volumes above referred to.

Mr. Distant's 'Monograph of Oriental Cicadidæ' certainly covers the same ground, but it is a much more elaborate work than we should have dared to hope for; in fact, a similar treatment of the Oriental Insect-fauna alone would produce a small library of books such as no Government could be expected to take the responsibility of publishing. But should the production of a series of Manuals of the Indian Invertebrata ever be realized, such books as Mr. Distant's will be of great importance in the identification of species, to be briefly described in the smaller works; but in that case we hope that they may not, as in the case of the late Dr. Day's 'Indian Fishes,' cause the elimination of nearly all synonymy.

That Mr. Distant's book will be somewhat voluminous may be inferred from the fact that this first part includes, besides the preliminary general matter, the descriptions of only twenty-eight species belonging to four genera, and leaves 9 genera still to be treated in his first subfamily of Cicadinæ. The descriptions are carefully drawn up, and the student ought to have little difficulty in determining the various species, especially with the aid of the beautifully-executed plates, two of which illustrate the present part. There is only one drawback to the treatment of the subject by the Author, namely, that he divides the family into two subfamilies, Cicadinæ and Tibiceninæ, solely upon characters belonging to the male insect, and that he seems inclined to lay rather much stress upon the development of the tympanic opercula, also a male character, in the distinction of species and genera; but with a book of which only a first instalment has appeared, any criticism is perhaps out of place.

Mr. Wood-Mason's 'Catalogue of Mantodea' is not so strictly an Indian book as Mr. Distant's. It is, in fact, a catalogue of the Insects of the family Mantodea contained in the Indian Museum; and although, as might be expected, it contains a great number of Eastern species, these are interspersed with others from various parts of the World, especially Africa and Australia, and even South America. This first part, which is probably about half of the entire work, includes notices of eighty-seven species, five of which are described as new, and the descriptions of some other species previously described by the Author are also given, as well as occasional notes on the characters of other forms, which are often illustrated with very instructive woodcut figures. Two new genera of Eremiaphilidæ are characterized under the names of *Paroxyophthalmus* and *Parepiscopus*, both for forms in which the eyes project upwards more or less in the shape of horns.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

November 20, 1889.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "On the Occurrence of the Striped Hyæna in the Tertiary of the Val d'Arno." By R. Lydekker, Esq., B.A., F.G.S.

A portion of the left maxilla of a Hyæna, in the British Museum, containing the entire carnassial, the hinder half of the third premolar, and traces of the inner extremity of a molar, was referred by the Author in 1885 to *H. striata*, and provisionally regarded as of Pleistocene age, but subsequently concluded to have been of Upper Pliocene age. The Author has also referred a right upper carnassial of a Hyæna from the Red Crag to the same species, on the supposition that Prof. Gaudry's reference of *H. arvernensis* to *H. striata* was correct. In the present case, Dr. Weithofer has concluded that *H. arvernensis* is entitled to rank as a valid species, and has accepted the Author's determination of the Red-Crag form, thereby implying that the identification of the latter with *H. arvernensis* was erroneous. Dr. Weithofer also states that all the specimens from the Pliocene of the Val d'Arno which have come under his notice are more nearly allied to the Crocutine group.

In the present paper, measurements of the recent, Red Crag, and Val-d'Arno specimens referred by the Author to *H. striata* were given, and the differences shown to be within the limits of individual variation, whilst the actual contour of the teeth corresponded, leading the Author to maintain the correctness of his original determination.

After comparison of the British-Museum specimen with the upper jaws of Hyænas from the Val d'Arno, figured by Dr. Weithofer, it was shown that the former specimen was distinct from *H. robusta* (which latter is allied to *H. felina* of the Siwalik Hills), whilst a nearer resemblance, though with well-marked specific difference, was made out with *H. topariensis*, which was in turn observed to be closely allied to, if not identical with, *H. Perrieri*.

It was observed that *H. arvernensis* could be with difficulty distinguished from *H. brunnea*, and that both of these were nearer to *H. striata* than to *H. crocuta*, whilst *H. Perrieri* appeared to connect them with the latter.

2. "On a new Genus of Siliceous Sponges from the Lower Calcareous Grit of Yorkshire." By Dr. G. J. Hinde, F.G.S.

The Author referred, in the first instance, to the discussion as to the nature of certain renuline bodies occurring in the Corallian of Yorkshire and elsewhere. Although regarded of late years as the globate spicules of a siliceous sponge, the apparent absence of acerate and forked spicules in association therewith has always presented a difficulty. Recently the Author has recognized in specimens from Scarborough certain siliceous sponges which seem to be formed entirely of globates. In outward appearance the sponge is upright, and palmate or fan-shaped, the largest being 140 millim. in height. The wall is 14 millim. thick, and consists of plates which anastomose so as to form a labyrinthine structure, and are perforated regularly by oval slits. The laminated walls are composed entirely of small reniform spicules (globates), well seen where secondary crystallization has not fused them together. The globates, like those of *Geodia*, are built up of fibres radiating from the centre, and terminating on the outer surface in nodose ends, which causes a spotted appearance.

The exceptional character of these fossils consists in their having the siliceous skeleton composed entirely of globates. The nearest living form is *Placospongia*, in which both the axis and the dermal crust are formed of globates with an interspace built up of numerous pin-like spicules. Assuming the absence of pin-like spicules in the Scarborough fossil, the differences are more than generic. The name *Renulina*, given by Blake to the globates, having been preoccupied, the Author proposed that of *Rhaxella* for the genus, and described the sponge from the Lower Calcareous Grit as *R. perforata*, sp. n.

December 4, 1889.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "On Remains of Small Sauropodous Dinosaurs from the Wealden." By R. Lydekker, Esq., B.A., F.G.S.

The Author first noticed some teeth from the Wealden of Sussex and the Isle of Wight, provisionally referred by Mantell, and subsequently by Sir R. Owen, to *Hylæosaurus*, which he had made the type of a species of *Pleurocœlus*. He then described the imperfect centrum of a dorsal vertebra from the Wealden of Cuckfield, preserved in the British Museum, and a somewhat larger imperfect vertebra obtained from the Wealden of Brook, Isle of Wight.

In the absence of any evidence in favour of a contrary view, he proposed provisionally to refer the vertebræ to *Pleurocœlus valdensis*, a name which he had given to the form represented by the teeth in a paper published in the 'Geological Magazine' for the current year. He stated that they afforded absolutely conclusive evidence of the occurrence in the English Wealden of a diminutive Sauropodous Dinosaur, which was the contemporary of the huge *Hoplosaurus* and the still more gigantic *Pelorosaurus*, and that they also served to increase the evidence as to the similarity of the Dinosaurian fauna of the Upper Jurassic of North America to that of the Upper Jurassic and Lower Cretaceous of Europe.

2. "On a peculiar horn-like Dinosaurian Bone from the Wealden." By R. Lydekker, Esq., B.A., F.G.S.

Among a series of vertebrate remains sent from the Dorsetshire County Museum to the British Museum, there is an imperfect, stout, short, cone-like bone from the Wealden of Brook, Isle of Wight. It appears to present a close resemblance to the horn-cores of the Dinosaur described by Prof. Marsh as *Ceratops*.

The Author did not regard the specimen as affording conclusive evidence of the existence in the Wealden of a large Dinosaur furnished with horn-like projections on the skull like those of the American *Ceratops*, but suggested that such might really prove to be its true nature.

December 18, 1889.—W. T. Blanford, LL.D., F.R.S.,
President, in the Chair.

The following communication was read:—

"On the Occurrence of the Genus *Girvanella*, and remarks on Oolitic Structure." By E. Wethered, Esq., F.G.S.

The Author referred to his previous work, wherein he had shown that *Girvanella* is not confined to Silurian rocks, and that as a rock-forming organism it is more important than was supposed, occurring in the Gloucestershire Pea-grit, and also in the Coralline Oolite of Weymouth. He now dealt more in detail with its occurrence (1) in the *Carboniferous Oolitic Limestone*; and (2) in the *Jurassic Oolites.*

In the Carboniferous Limestone of the Avon valley, oolitic limestone occurs on four horizons, in three of which the Oolites rest on dolomite. In none of these three cases are there signs of *Girvanella.* From beds partly Oolitic, and not resting on dolomite, he has been able to determine two new species. The Oolite not associated with dolomite is less crystalline, and the original structure is better preserved.

In referring to *G. pisolitica*, he discussed whether *Girvanella* is most allied to the 'Challenger' Foraminifer, *Hyperammina vagans*, or to *Syringammina fragilissima.* Traces of the organism occur in the *Clypeus*-grit, but none are quoted from beds of the Great Oolite, nor from the Portland Oolite. The Author had already shown that the pisolites in the Coralline Oolite of Weymouth were not concretions, but forms of *Girvanella.* Excluding these, he showed that the spherules are of four types, of which one is the ordinary oolitic granule, while each of the others suggests the presence of *Girvanella.*

The characters of the genus, as seen under the microscope, were indicated, and four new species were described.

MISCELLANEOUS.

Note on a Young Specimen of Zoarces viviparus.
By Ernest W. L. Holt, Marine Laboratory, St. Andrews.

On the 4th Jan. a female viviparous blenny extruded between forty and fifty young in the tank-room. Such of the young as were examined at the time measured, within a narrow margin, 2 inches. On the 25th Jan. several were measured, but, owing probably to the meagreness of the food-supply, little or no increase of growth was observable, the length varying from 2 to $2\frac{1}{12}$ inches. To this, however, there were two exceptions. One measured $1\frac{1}{2}$ inch, the other only $1\frac{1}{12}$ inch; the former appears normal in every respect except size, the latter is darker than the rest and exhibits a downward bend of the notochord about $\frac{1}{8}$ inch from its posterior end. The yolk-sac has disappeared, though the animal is shorter than a larval form two months before extrusion. Indeed, it is likely that the yolk was absorbed before extrusion, otherwise it would not have escaped attention so long.

In examining a number of pregnant females this winter, I have been struck with the frequent occurrence in the earlier stages of one or more deformed embryos. The deformity appears confined to the caudal region, which is bent, or even spirally twisted. Ryder * and others have shown that in some normal oviparous fish the tail of the embryo is affected in a similar way by unfavourable conditions of temperature. But it does not appear that any so-affected embryos hatched.

Here it is evident that the deformity, however caused, has had no effect on the embryo beyond retarding its growth. The little creature has the ordinary proportions of a larval form of the same length, and appears active and healthy, feeding greedily on Copepods.

The young blennies at this age lie quietly at the bottom of the vessel in which they are confined, ever and anon making a dart at a passing Copepod. They rarely rise into midwater, though Copepods are much more abundant near the surface than at the bottom.

On the Relationship of the Annelida and Mollusca.
By M. A. GIARD.

In the Report on the great prize in the physical sciences published in the 'Comptes Rendus' of the 30th December, 1889 (p. 1055), it is said:—"What especially merits attention in the memoir of M. Roule is the place which he assigns to the Annelida in the animal series. *He makes them near relatives of the Mollusca.*"

With reference to this passage M. Giard remarks that long before both Roule and Hatschek he expressed the same opinion. In 1876, at the close of a note upon the development of *Salmacina Dysteri*, Huxl., he wrote as follows †:—

"*General results.*—The formation of the organs of sense independently of the nervous system, and before the completion of that system, the presence of ectodermic respiratory organs, the late origin of the circulatory apparatus, are so many characters approximating the embryo of *Salmacina* to that of the Mollusca. The divergence between the Mollusca and the Annelida only commences after the *Trochosphæra*-stage, and even after this stage the morphological agreements and histological resemblances between the two types are still very numerous. *The relationship of the Mollusca and the Annelida is certainly nearer than that of the latter to the Arthropoda*; the existence of metameres in the Arthropoda and the Annelida has

* 'Report of Commissioner U.S. Fish and Fisheries Commission,' 1885, p. 532.

† 'Comptes Rendus,' January 24, 1876.

masked the true affinities in the eyes of naturalists. It is among the Rotifera that we must seek the origins of the three groups; the Gastrotricha lead to the Annelida through the genus *Hemidasys* *. . . . . The affinities of the embryos of the Gasteropoda with those of the Rotifera (*Brachionus*) have already been brought to light by the fine investigations of Salensky."

Somewhat later † the author maintained that the perfect agreement furnished by the superposition of the first embryonic stages and the general presence of the *Trochosphæra*-stage in the Mollusca, Polychætous Annelida, Rotifera, Brachiopoda, and Bryozoa show clearly that these various groups belong to a single mass. To the objection that the embryogeny of the Oligochæta, Hirudinea, Cephalopoda, and Nematoda presents considerable differences from that of the above types, he replies that these groups are so united to the preceding ones by a series of forms allied anatomically and organogenetically that we must regard them as the extremities of those branching series of which Lamarck indicated the existence in the heart of his fundamental masses. Some of them perhaps (Nematoda, Oligochæta) diverged from the common stem before the *Trochosphæra*-stage. External form may be misleading—there is more difference between an *Ascaris* and a *Serpula* than between a *Serpula* and a *Terebratula*. From the anatomical conformity between the Oligochæta and the Polychæta it would seem that, at least in this case, there has simply been falsification of the embryogeny in the former. As *Euaxes* and *Lumbricus* issue from the ovum nearly in the adult form, the *Trochosphæra*-stage has been suppressed. In *Limnæus* the embryo leads a half-free life in the liquid which surrounds it, and we find a Trochosphere reduced in proportion to the freedom of movement.

In 1878 ‡ the author insisted again upon the necessity of creating for the Mollusca, Annelida, and satellitic groups, a group equivalent to the Vertebrata and Arthropoda, for which he proposed the name of *Gymnotoca*. It was characterized anatomically by the existence of a secondary excretory system (deutonephra or segmental organs) replacing the primary excretory system (protonephric system), the existence of which is permanent in the ancestral group of the Platyelmintha. The phylum Gymnotoca was divided as follows:—

GYMNOTOCA
1. Mollusca: Cephalopoda, Gasteropoda, Acephala, Scaphopoda, Polyplacophora, and Neomenida.
2. Annelida: Chætopoda, Gymnotoma (*Polygordius*), Hirudinea, Gephyrea, Chætognatha, &c.
3. Brachiopoda.
4. Ciliata: Rotifera, Gasterotricha, Bryozoa.

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* M. Giard now regards *Dinophilus* as more ancestral, but this is only of secondary importance here.

† 'Revue Scientifique,' March 18, 1876, p. 277.

‡ Bull. Sci. du Nord, 1878, pp. 47 *et seqq.*

From the embryogenetic point of view the Gymnotoca are characterized by the *Trochosphæra*-larva, like the Arthropoda by the *Nauplius*-embryo.

The phylogenetic table of the Gymnotoca given by M. Giard in 1876 may be compared with the genealogical tree of the Trochozoa prepared by M. Roule in 1889, and, according to the author, the only essential alteration consists in the adoption by the latter of Hatschek's term Trochozoa.

In attempting to homologize the schizocœle of the higher Gymnotoca with the enterocœle of the more archaic forms (*Sagitta*, Brachiopoda), the fact that the original mesodermic cells in the schizocœlian types originate from the endoderm, at the margin of the prostomium, in points perfectly homologous with those in which the endodermic diverticula are formed in the enterocœlians, led the author at first to regard the latter as representing the primitive state, of which the derived (condensed) form is realized in the Mollusca and Annelida. His later researches have enabled him to generalize this interpretation and to formulate the following empirical law:—

"*When, in the development of allied animals, an organ originates either by invagination or folding of a cellular lamella* (*Wolffian process*), *or by the formation of a solid cellular mass which is afterwards cleft or hollowed by a cavity, the latter mode of formation must be regarded as a condensation of the former.*"

This formula may be applied to the Gymnotoca not only in the question of the two forms of mesoderm, but also in the comparison of the *archigastrula* (*Sagitta*, Brachiopoda) and of the derived modes of gastrulation in the formation of the ventral nervous system by a furrow (*Salmacina*, *Protodrilus*) and by thickening &c. With regard to the nervous system and to the ectoderm generally the author states that in no Annelid examined by him has he seen anything like the syncytium described by M. Roule. The contours of the ectodermic cells can always be shown by suitable reagents.—*Comptes Rendus*, January 15, 1890, p. 90.

On the Fauna of Mountain-lakes. By Dr. F. Zschokke.

The faunistic investigation of three neighbouring alpine lakes of the Rhætic Alps, the dividing chain between Vorarlberg and Graubünden, gave the following results:—

a. *Lake of Partnun*: elevation 1874 metres; length 450, breadth 200, depth 35 metres; temperature 9°·5–10°·5 C. The basin is enclosed by lofty rocky walls in the midst of the limestone mountains; its bottom consists partly of fine mud, partly of coarse gravel. A green Algal vegetation is rather luxuriantly developed in the lake, while the banks are scantily covered with plants. Almost throughout the whole summer the basin receives a great influx of snow-water. The surface is frozen over in the first half of November to open again at the beginning of June.

Animal inhabitants:—*Vorticella microstoma*, Ehr.; *Planaria abscissa*, Ijima; *P. subtentaculata*, Dugès; *Dorylaimus stagnalis*, Duj.; *Sænuris variegata*, Hoffm.; *Lumbriculus variegatus*, O. F. Müll.; *Lynceus quadrangularis*, O. F. Müll.; *L. sphæricus*, O. F. Müll.; *Cypris compressa*, Baird; *Cyclops tenuicornis*, Claus; *C. elongatus*, Claus; *Hygrobates longipalpis*, Könicke; *Limneria histrionica*, Bruz.; *Pachygaster tau-insignitus*, Lebert; *Cirrhenurus* spec., Dug.; *Rhyacophila vulgaris*, Pict.; *Chironomus plumosus*, Linn.; *Chironomus*, 5 sp., Meig.; *Tipula* sp., Meig.; *Corethra* sp., Meig.; *Pisidium fossarinum*, Cless.; *P. Foreli*, Cless.; *Limnæa truncatula*, Müll.; *L. ventricosa*, Moq.-Tand.; *Cottus gobio*, Linn.; *Phoxinus lævis*, Ag.; *Rana temporaria*, Linn.; *Triton alpestris*, Laur.

b. *Lake of Tilisuna*: elevation 2100 metres; length 270, breadth 150, depth 15 metres; temperature 11°–12° C. The lake lies more open than that of Partnun, partly in Bündnerschiefer, partly in crystalline rock. The subsoil is composed chiefly of coarse pebbles. Vegetation in the water inconsiderable, on the bank tolerably luxuriant. This basin also receives a great influx of snow-water. The periods of freezing and breaking-up agree nearly with those of the Partnun lake.

Animal inhabitants:—*Vorticella microstoma*, Ehr.; *Planaria polychroa*, O. Schm.; *Dorylaimus stagnalis*, Duj.; *Sænuris variegata*, Hoffm.; *Lynceus quadrangularis*, O. F. Müll.; *L. acanthocercoides*, Fisch.; *Cypris compressa*, Baird; *Phryganea pilosa*, Oliv.; *Hydroporus piceus*, Heer; *Chironomus plumosus*, Linn.; *Chironomus* sp., Meig.; *Pisidium nitidum*, Jenyns; *Limnæa truncatula*, Müll.; *Fredericella sultana*, Gerv.; *Cottus gobio*, Linn.; *Phoxinus lævis*, Ag.; *Rana temporaria*, Linn.

c. *Lake of Garschina*: elevation 2189 metres; length 200, breadth 100, depth 3 metres; temperature 15°–16° C. It lies quite open in the midst of fine Alpine meadows. Its bottom consists of fine mud; the surrounding rock is a Bündnerschiefer, rich in Fucoids. Algal vegetation much developed in the lake. The influx of snow-water ceases entirely in the summer; the basin is then fed only by springs. The ice-covering breaks up only at the end of June.

Animal inhabitants:—*Epistylis plicatilis*, Ehr.; *Vorticella microstoma*, Ehr.; *Calidina parasitica*, Gigl.; *Microstoma lineare*, Oerst.; *Planaria abscissa*, Ijima; *Polycelis nigra*, O. F. Müll.; *Dorylaimus stagnalis*, Duj.; *Clepsine bioculata*, Sav.; *C. marginata*, Sav.; *Sænuris variegata*, Hoffm.; *Lumbriculus pellucidus*, Dupel; *Lynceus quadrangularis*, O. F. Müll.; *Cypris compressa*, Baird; *Cyclops serrulatus*, Fisch.; *Diaptomus castor*, Jur.; *Gammarus pulex*, Linn.; *Limnesia histrionica*, Bruz.; *Pachygaster tau-insignitus*, Lebert; *Perla alpina*, Pict.; *Cloë* sp., Pict.; *Sialis lutaria*, Linn.; *Phryganea varia*, Fab.; *P. pilosa*, Oliv.; *P. ruficollis*, Pict.; *Notonecta lutea*, Müll.; *Hydroporus nivalis*, Heer; *H. erythrocephalus*, Heer; *Chironomus*, 4 sp., Meig.; *Corethra* sp., Meig.; *Pisidium fossa-*

rinum, Cless.; *P. ovatum*, Cless.; *Limnæa truncatula*, Müll.; *Cottus gobio*, Linn.; *Phoxinus lævis*, Ag.; *Rana temporaria*, Linn.; *Triton alpestris*, Laur.

The results here communicated were obtained in August 1889, during a long zoological excursion, which was unfortunately much interfered with by unfavourable weather. The examination of the three basins referred to, which are so different in every respect, will be continued for several years. At the same time the investigations will be extended to some other lakes of the Rhætic Alps, especially to the Lünersee, on the Seesaplaner. In this way it may be possible to obtain a complete picture of the Lake-fauna of a definite, narrowly bounded Alpine region, and at the same time to approach more closely to certain biological questions. The faunistic and biological results of 1889 are described in detail in a report which appears in the 'Verhandlungen der Naturforschenden Gesellschaft in Basel.'

Protozoa and Rotatoria were this time not particularly collected; but these groups will be studied in future years. The lists of the other groups must also be greatly enriched.—*Zoologischer Anzeiger*, No. 326, January 27, 1890, p. 37.

On the Actinian Genera Ægir *and* Fenja.

By Prof. F. E. Schulze and Dr. D. C. Danielssen.

In a 'Notice on the Actinida of the Norwegian North-Atlantic Expedition,' published in the Annual Report of the Museum at Bergen, Dr. Danielssen described two new genera, allied in appearance to *Peachia* and *Edwardsia*, but in which a complete intestine was said to pass from the mouth to the posterior extremity of the body, to open there in a functional anal pore. In a communication to the 'Gesellschaft Naturforschender Freunde zu Berlin,' on the 19th February, 1889, Prof. F. E. Schulze expressed some doubt as to the validity of these descriptions, and suggested that the forms in question might possibly have been examples of species of the family Edwardsiidæ which had been cut in two by the dredge. In answer to this suggestion Dr. Danielssen wrote to his critic, and a portion of his letter was read by the latter at the meeting of the same society on the 16th April last. Dr. Danielssen says:—

"You must not forget that I am an old zoological fisherman, who has worked with the dredge for fifty years, and that during this time I have met with hundreds and hundreds of animals which were mutilated in one way or another. From many years' experience, therefore, I can perfectly well distinguish such specimens from uninjured ones. And if your supposition were correct, and I had had to do with the torn-off anterior parts of animals, then, even if a mistake had been at all possible, the lower extremity of the animal must show a constriction which would at once strike the experienced observer. Such a constriction, in fact, does occur in certain injured specimens, in which, moreover, the lower extremity of the body-cavity is open; but it is entirely wanting in the well-preserved individuals described. In the latter the lower extremity of the body-cavity, which is divided into 12 chambers, is closed by a distinct floor, which surrounds the anus, and is divided by the 12 septa into the same number of segments. In each of these segments, in *Fenja*, there is an exceedingly fine oval aperture, partly covered by a fold; both the floor and the aperture are clothed with epithelium. Here, consequently, there can be no question of tearing away.

"As regards *Ægir*, here also the described animals were quite uninjured. Some specimens were torn by the dredge, but could be distinguished from the uninjured ones without any difficulty. In *Ægir* the body-cavity is likewise divided into 12 chambers by 12 septa, which reach to the floor, where they are firmly attached, and which they consequently divide into 12 segments surrounding the anus. At the lower end of the rectum in this animal there are fissures through which the chambers of the body-cavity communicate with the rectum. These fissures do not extend to the anus, but terminate some millimetres above it and are clothed with epithelium. During the observation of living animals I frequently saw tolerably long, solid masses of excrement discharged from the anus, after which the aperture contracted again. In *Ægir* consequently there can be no question of mutilation."—*Sitzungsber. Gesellschaft Naturf. Freunde zu Berlin*, 1889, pp. 55 and 99.

On the Anatomy and Developmental History of Petromyzon Planeri. By M. K. Nestler.

Investigations upon *Petromyzon Planeri* made by the author in Prof. Leuckart's laboratory have revealed some interesting facts, especially with regard to the development of the definitive œsophagus during the metamorphosis. Dr. Schneider, in his "Contributions to the Comparative Anatomy and Developmental History of the Vertebrata," states that the œsophagus is produced as a new formation, an invagination originating from the anterior extremity of the intestinal fold, continuing forwards the mesenterial fold of the stomach, and running into the dorsal margin of the branchial cavity. Although at first hollow, this soon becomes solid, and then extends, as a solid cellular cord, to the velum. The latter thus furnishes not only the epithelium, but also the mucous membrane and musculature of the œsophagus.

The author's investigations led to different results. The œsophagus really originates as a *solid cord*, but its cells furnish *only the epithelium* of the definitive œsophagus, the central cell-material being absorbed; *the musculature originates from the surrounding connective tissue.*

Moreover the œsophagus is not formed as an invagination from the anterior extremity of the intestinal fold, but *as a pad-like epithelial growth along the lower border of the dorsal fold in the branchial space,* which, being afterwards constricted off at its base by the surrounding connective tissue, becomes a solid cellular cord running in the depths of the fold. The starting-point of the whole new formation is certainly the spot at the end of the branchial space where the entrance to the stomach is closed by the thickening of the lips surrounding it.—*Zool. Anzeiger*, January 13, 1890, p. 11.

The Amphipoda of the Boulonnais.—I. Unciola crenatipalmata, *Spence Bate.* By M. Jules Bonnier.

In this paper, which is illustrated by two plates, the author gives a detailed description of the Amphipod Crustacean first described by Gosse as identical with the *Unciola irrorata* of Say, and afterwards recognized as distinct by Spence Bate and described by him under the name of *Dryope crenatipalmata.* The author discusses at some length the characters presented by the species, and gives the following series of tables to serve for its identification :—

I. Amphipoda.

Pleon well developed.	Six pairs of pleopods.	Maxilliped rudimentary		HYPERINA.
		Maxilliped well developed.	Sixth pleopod with an endopodite....	GAMMARINA.
			Sixth pleopod with no endopodite....	COROPHINA.
			Fifth and sixth pleopods without endopodites..........	CERAPINA.
	Five pairs of pleopods			DULICHINA.
Pleon rudimentary				LÆMODIPODA.

II. Corophina.

Mandibular palpus wanting			Orchestiidæ.
Mandibular palpus of two or three joints.	Coxopodites of the pereiopods broadly developed.	Joints 2 and 3 of the maxilliped narrow.	Stenothoidæ.
		Joints 2 and 3 of the maxilliped lamellar	Microprotopidæ.
	Coxopodites of the pereiopods narrow and not well developed		Corophiidæ.

III. Corophiidæ.

Corophiidæ.	Mandibular palpus of 2 joints				*Corophium.*
	Mandibular palpus of 3 joints; last 3 segments of pleon	free; basipodite of sixth pleopod	dilated; mandibular palpus with joint 3	elongate	*Unciola.*
				nodiform	*Siphonœcet*
			narrow; first pereiopod	less developed than the second.	*Erichthoni*
				more developed than the second.	*Neobela.*
		coalescent			*Chelura.*

IV. Unciola.

Joints 2, 3, and 4 of the inferior antennæ	narrow; third joint of antennule	two thirds length of second; margin of propodite of second pereiopod	crenulated	*U. crenatipalm*
			simple	*U. irrorata.*
		one third length of second; accessory flagellum of antennule	of a single joint.	*U. planipes.*
			pluriarticulate.	*U. crassipes.*
	broad; infero-posterior part of fourth joint with the margin	produced into a point		*U. petalocera.*
		broadly rounded		*U. laticornis.*

The genus *Unciola* was established by Say in 1818, and adopted by Milne-Edwards and other authors. Synonyms are *Dryope*, Sp. Bate, *Glauconome*, p. Kröyer, and *Cyrtophium*, p. Danielssen.

The species referred to the genus, as seen in the above table, are:—1. *Unciola crenatipalmata*, Sp. Bate (=*irrorata*, Gosse, nec Say), of the seas of western Europe; 2. *U. irrorata*, Say (=*Glauconome leucopis*, Kröyer, and *Cyrthophium Darwinii*, Danielssen), from the Arctic seas and those of Britain and Norway; 3. *U. planipes*, Norman (=*leucopes*, Sp. Bate and Westw., *Glauconome Kroeyeri* and *Steenstrupii*, Boeck), from the shores of Greenland, Norway, England, and France; 4. *U. petalocera*, G. O. Sars, from the Arctic Ocean; 5. *U. crassipes*, Hansen, from the west coast of Greenland; and 6. *U. laticornis*, Hansen, from the same region.—*Bull. Scient.* tome xx. 1889, pp. 229–254.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

No. 28. APRIL 1890.

XXXIX.—*Descriptions of new and imperfectly-defined Species of Jurassic Nautili contained in the British Museum (Natural History).* By Arthur H. Foord, F.G.S., and G. C. Crick, Assoc.R.S.M., F.G.S., of the Geological Department, British Museum.

In studying the Jurassic Nautili in the British Museum it became evident to us that many of the species required revision, Sowerby's names especially having been used by authors indiscriminately for forms which, on investigation, were found to disagree materially with the types. It has been our endeavour, with the aid of the excellent material furnished by the National Collection (which contains many of Sowerby's types), to give such definitions and figures of the species as may conduce to their correct identification by future workers. We have found it necessary to create some new species, which have been derived chiefly from the rich Jurassic fauna of Dorset and Somerset. Two species are included from the Lias of France; and we here record our indebtedness to Dr. Paul Fischer, of the Museum of Natural History, Paris, who with great kindness sent us some specimens from the d'Orbigny Collection to compare with those of the British Museum. We have also the pleasure to acknowledge the liberal assistance rendered to us by the authorities of the Woodwardian

	Lias.
1. *Nautilus simillimus*, sp. nov. 2. —— *Jourdani*, Dumortier. 3. —— *terebratus*, Dumortier. 4. —— *robustus*, sp. nov. 5. —— *Fischeranus*, sp. nov.	*Nautilus striatus*, J. Sowerby, Min. Conch. vol. ii. p. 183 (1817), pl. clxxxii. —— *intermedius*?, J. Sowerby, Min. Conch. vol. ii. p. 53 (1817), pl. cxxv. —— *araris*, Dumortier, Études Paléontologiques du Bassin du Rhône, pt. iii. (1869), p. 56, pls. vi., vii. —— *truncatus*, J. Sowerby, Min. Conch. vol. ii. p. 49 (1816), pl. cxxiii. —— *semistriatus*, d'Orbigny, Pal. Franç., Terr. Jurass. vol. i. (1842), p. 149, pl. xxvi. —— *toarcensis*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. i. (1849), p. 245 (= *N. lati-dorsatus*, d'Orbigny, Pal. Franç., Terr. Jurass. vol. i. (1842), p. 147, pl. xxiv.). —— *astacoides*, Young and Bird, Geol. Surv. Yorkshire Coast, 1828, 2nd ed. p. 270, pl. xiii. fig. 2.
	Lower Oolite.
6. —— *ornatus*, sp. nov. 7. —— *lineatus*, J. Sowerby. 8. —— *pseudolineatus*, sp. nov. 9. —— *glaber*, sp. nov. 10. —— *obesus*, J. Sowerby. 11. —— *inornatus*, d'Orbigny. 12. —— *multiseptatus*, sp. nov. 13. —— *clausus*, d'Orbigny. 14. —— *perinflatus*, sp. nov. 15. —— *Smithi*, sp. nov. 16. —— *burtonensis*, sp. nov.	—— *polygonalis*, J. de C. Sowerby, Min. Conch. vol. vi. p. 56 (1826), pl. dxxx. —— *excavatus*, J. de C. Sowerby, Min. Conch. vol. vi. p. 55 (1826), pl. dxxix. fig. 1. —— *Baberi*, Morris and Lycett, Gt. Oolite Mollusca (Mon. Pal. Soc. 1850), pt. i. p. 10, pl. i. figs. 1, 1 *a*. —— *subtruncatus*, Morris and Lycett, Gt. Oolite Mollusca (Mon. Pal. Soc. 1850), pt. i. p. 10, pl. i. figs. 2, 2 *a*.
	Middle Oolite.
17. —— *calloviensis*, Oppel.	—— *hexagonus*, J. de C. Sowerby, Min. Conch. vol. vi. p. 55 (1826), pl. dxxix. fig. 2.

Museum, Cambridge, and those also of the Museum of Practical Geology, who lent us specimens from their valuable collections. It may be added that all the illustrations accompanying this paper were drawn by one of us upon the wood (upon a reduced scale) with the aid of a camera, by which means accuracy of outline is secured.

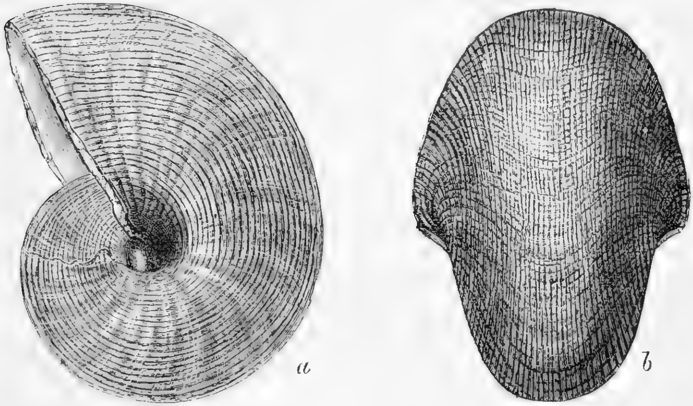
We are again indebted to the kindness of Dr. Woodward, F.R.S., for the use of the woodcuts illustrating this paper.

Appended is a list (p. 266) of the species of Jurassic Nautili contained in the British Museum. The new and revised species are placed in the first column, and in the second those which do not require revision and are therefore not described in the present paper; of each of the latter, however, we give the reference to the original description.

LIAS.

1. *Nautilus simillimus*, sp. nov.

Fig. 1.



Nautilus simillimus.—*a*, lateral view of a young individual, showing the closed umbilicus; *b*, peripheral view. Drawn from a specimen in the British Museum. Nearly two thirds natural size.

Sp. char. Shell somewhat compressed on the sides, narrowly rounded on the periphery, completely involute. Umbilicus closed by a shelly callus. Septa moderately distant; sutures slightly curved on the sides of the shell and forming a shallow sinus upon the periphery. Siphuncle unknown. Test ornamented with fine, close-set, subregular, wavy, longitudinal ridges, which are somewhat coarser on the sides of the shell than on the periphery; finer lines are intercalated between these, and the whole are crossed by fine and numerous lines of growth, which impart a cancellated appearance to the test, especially in young shells. In addition to the finer ornaments there are a series of obscure folds radiating from the umbilicus, and dying out upon the periphery.

Remarks. This species resembles *Nautilus striatus*, J. Sowerby *, in its general form and perfectly in its sculpture, but it is distinguished by its completely closed umbilicus. A large but imperfect and crushed example (no. 39850) represents the adult stage in the growth of the shell, while the young is exemplified in an exquisitely preserved specimen (no. 39887). The name *simillimus* which we have given to this species is intended to express its close resemblance to *N. striatus.*

Horizon. Lias.

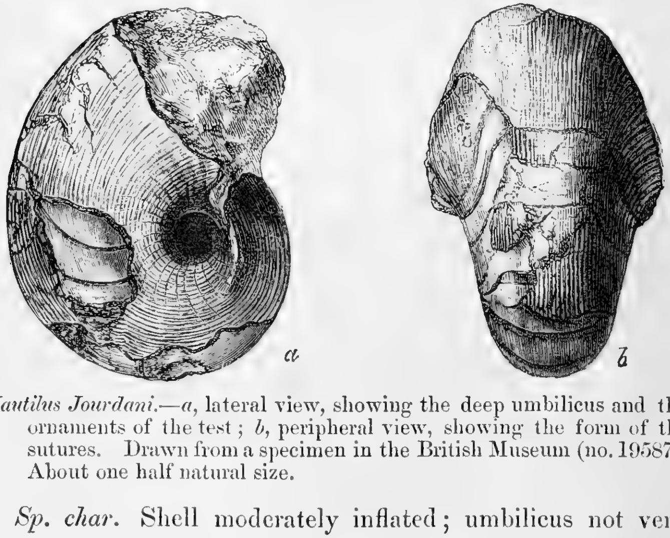
Locality. Charmouth, Dorsetshire.

2. *Nautilus Jourdani*, Dumortier.

1874. *Nautilus Jourdani*, Dumortier, Études Paléontologiques sur les Dépôts Jurassiques du Bassin du Rhône, pt. iv. (Lias Supérieur) p. 44, pl. vii. figs. 1–5.

1889. *Nautilus Jourdani*, S. S. Buckman, Quart. Journ. Geol. Soc vol. xlv. p. 453 (footnote).

Fig. 2.



Nautilus Jourdani.—*a*, lateral view, showing the deep umbilicus and the ornaments of the test; *b*, peripheral view, showing the form of the sutures. Drawn from a specimen in the British Museum (no. 19587). About one half natural size.

Sp. char. Shell moderately inflated; umbilicus not very

* Min. Conch. vol. ii. p. 183, pl. clxxxii.

large; whorls flattened both on the sides and on the periphery, the greatest thickness being at the umbilicus. The sides of the latter are steep and the borders subangular, the test being here very thick. The septa, of which there are about thirteen in an entire whorl, form a strongly marked sigmoidal curve upon the sides of the shell, but are only very slightly sinuous on the periphery. The siphuncle is situated a little below the centre. The test is covered with numerous, thread-like, longitudinal ridges, two or three in the space of 1 line, more approximate on the periphery than on the sides, as is usually the case with such ornaments. The ridges become partly obsolete when the shell has attained a certain diameter, say between 4 and 5 inches. Fine lines of growth are seen where the shell is well preserved, especially in the region of the umbilicus.

It should be added that the interior of the umbilicus is ornamented with fine, radiating, flexuous ridges directed forward; these are crossed by spiral ridges somewhat widely spaced.

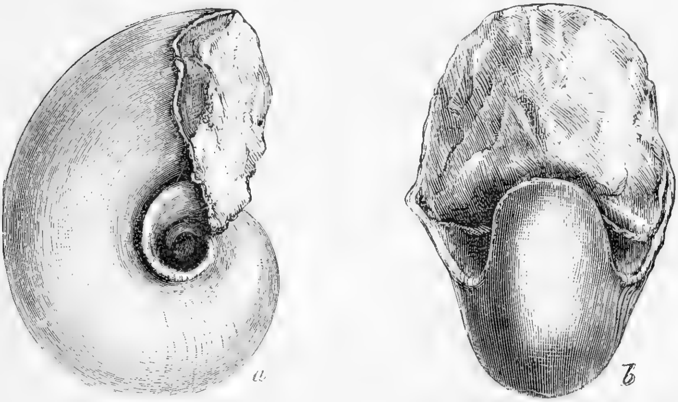
Remarks. This species is distinguished from *N. ornatus* (to be subsequently described), which appears to be its nearest ally, by its more compressed form, more angular umbilicus, and finer sculpture.

Horizon. Upper Lias.

Locality. Floore, Northamptonshire.

3. *Nautilus terebratus*, Dumortier.

Fig. 3.

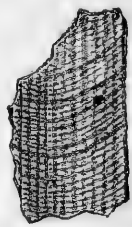


Nautilus terebratus.—*a*, lateral view, showing the raised border of the umbilicus; *b*, front view. Drawn from a specimen in the British Museum (no. C. 3096). Two thirds natural size. Except in well-preserved specimens the longitudinal ornaments are barely visible; we have therefore given a separate figure of them (fig. 4).

1874. *Nautilus terebratus* (Thiollière), Dumortier, Études Paléontologiques sur les Dépôts Jurassiques du Bassin du Rhône, pt. iv. (Lias Supérieur), p. 42, pl. vi. figs. 1–4.

Sp. char. Shell inflated, subglobose, a little compressed on the sides, and slightly flattened upon the periphery, more so in the adult than in the young shell. Aperture wider than high. Umbilicus open, exposing the inner whorls, very deep, the sides steep and having an angular border with a thickened rim, which is very characteristic. Septa rather distant, being nearly 1 inch apart on the periphery, where the height of the whorl is 2 inches in the specimen measured. Sutures very slightly bent upon the sides of the shell and forming a very shallow sinus upon the periphery. Siphuncle nearly central. Test rather thin, ornamented on the periphery with fine, close-set, longitudinal ridges, crossed by lines of growth, the latter covering the whole of the surface of the test. The accompanying woodcut (fig. 4) exhibits these ornaments drawn natural size, from a specimen in the British Museum Collection.

Fig. 4.



Remarks. The name *terebratus* was attached by Thiollière to a specimen in the museum at Lyons, and the species was subsequently described by Dumortier (*loc. cit.*), whose figures and descriptions enabled one of us to recognize it in the Woodwardian Museum, Cambridge, where it is well represented. The authorities of that Museum having kindly presented a specimen to the British Museum, we are enabled to give figures of this well-characterized species, which is now recorded in Britain for the first time.

This species has two characters in common with *Nautilus Jourdani*, Dumortier, viz. an angular umbilicus and longitudinal ornaments; but the latter are confined to the peripheral region, and the umbilicus has a very characteristic rim.

M. Dumortier states that he only knows this species from La Verpillière *, where it is not very rare; but entire specimens are uncommon. He adds that it is one of the most characteristic shells of the Upper Lias of France.

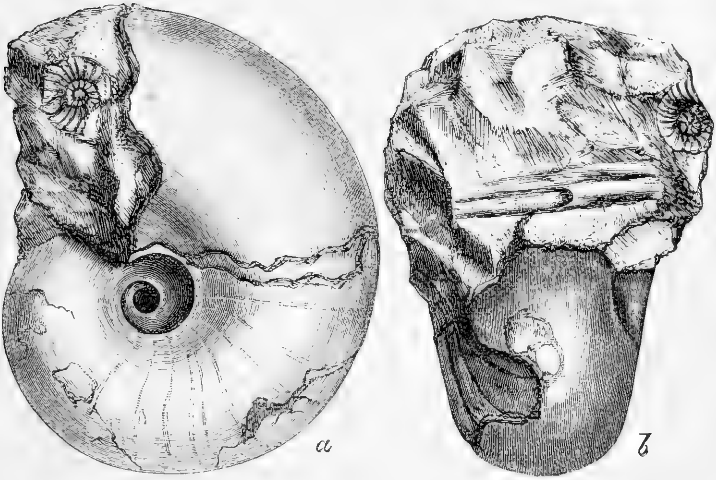
Horizon. Upper Lias.

Locality. Near Lincoln.

* A village in the Department of Isère, about 18 miles north-east of Vienne.

4. *Nautilus robustus*, sp. nov.

Fig. 5.



Nautilus robustus.—*a*, lateral view, showing the cast of part of the body-chamber, the test being present in the septate part of the shell, where a few lines of growth are indicated; *b*, front view. Drawn from a specimen in the British Museum (no. 37010). Rather less than one third natural size.

Sp. char. Shell of robust habit, slightly compressed on the sides and flattened on the periphery, especially towards the aperture; the angles formed by the junction of the sides and periphery rounded. Umbilicus open and exposing almost all the inner whorls; its sides rounded and rather steeply sloping. Aperture wider than high. Septa 1 inch distant from each other in the median line of the periphery, where the whorl has a thickness of $3\frac{1}{2}$ inches; in the middle of the sides their distance is only half an inch; the last two septa are only three quarters of an inch apart on the periphery. The siphuncle has not been seen. The body-chamber occupies at least one half of the last whorl. The test is very thick and its surface smooth, or marked only with lines of growth, as seen in fig. 5, *a*.

Remarks. There are three examples of this fine species in the British Museum Collection, two of which are adult shells and the other in the adolescent stage of growth. The largest specimen (the figured one) measures about 8 inches in its greatest diameter and about $5\frac{1}{2}$ inches in its greatest width.

This species is most nearly allied to *Nautilus toarcensis*, d'Orbigny *, but is distinguished by its narrower form, more open umbilicus, and closer septa.

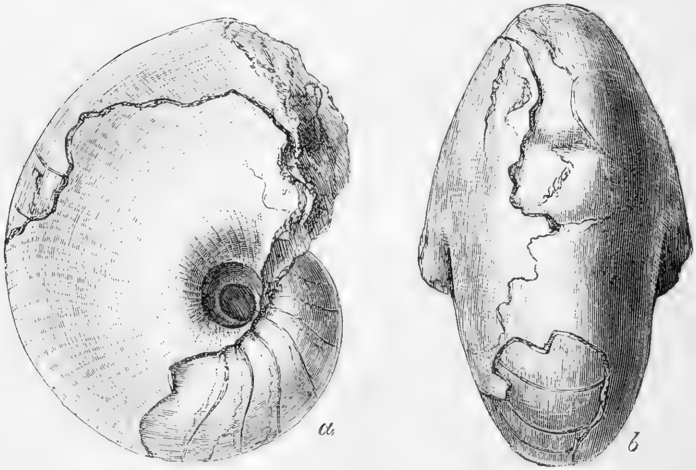
Not feeling certain that the present species had not already been described, we communicated with Dr. Paul Fischer, of the Mus. d'Hist. Nat. Paris, enclosing woodcuts of this and of another species described in the present paper under the name of *N. Fischeranus.* Dr. Fischer has kindly replied to the effect that he finds no form either in the Museum of Nat. Hist., the Museum of the École des Mines, or in that of the Sorbonne, which can be identified with certainty with either of our specimens. With regard to the form here called *N. robustus*, he observes that it resembles perhaps some specimens of *Nautilus toarcensis*, d'Orb., but that the umbilicus in the latter appears more open and the aperture more dilated. With these remarks we fully concur, and we are glad to have the opinion of so experienced a palæontologist as Dr. Fischer in confirmation of our own.

Horizon. Upper Lias.

Localities. Moutiers, Courcy † (Calvados), France.

5. *Nautilus Fischeranus*, sp. nov.

Fig. 6.



Nautilus Fischeranus.—*a*, lateral view, showing the test with fine lines of growth and some of the sutures, where the shell is removed; *b*, peripheral view. Drawn from a specimen in the British Museum (no. 37007). Rather more than one third natural size.

* Prodr. de Paléont. Stratigr. vol. i. p. 245, = *N. latidorsatus*, d'Orb. Pal. Franç., Terr. Jurass. vol. i. p. 147, pl. xxiv. (not of Schlotheim).

† Courcy is a village about $3\frac{1}{2}$ miles north-east of Falaise.

Sp. char. Shell compressed, with deeply embracing whorls, rapidly increasing in diameter; flattened upon the sides, with a narrowly rounded periphery. Umbilicus deep, with rather steeply sloping sides, the inner whorls exposed. Septa somewhat distant from each other, being about three quarters of an inch apart in the median line of the periphery, where the thickness of the whorl is 2 inches. Sutures slightly curved upon the sides and forming a very shallow sinus upon the periphery. Test smooth, showing only irregular lines of growth. Only a part of the body-chamber is preserved, so that the proportion it bears to the septate part of the shell cannot be ascertained.

Remarks. The present form is so unlike any other fossil *Nautilus*, that no comparison can be made.

A figure of the present species was submitted to Dr. Paul Fischer (along with one of *N. robustus*), and he fails to identify it with any species known to him, but suggests the possibility of its being represented in the private collection of the late Eugène Eudes-Deslongchamps at Caen. However this may be, we, like Dr. Fischer, can find no published description or figure which can be identified with it.

We have much pleasure in dedicating this beautiful species to Dr. Paul Fischer, of Paris, who has laid us under many obligations in connexion with the Jurassic Nautili.

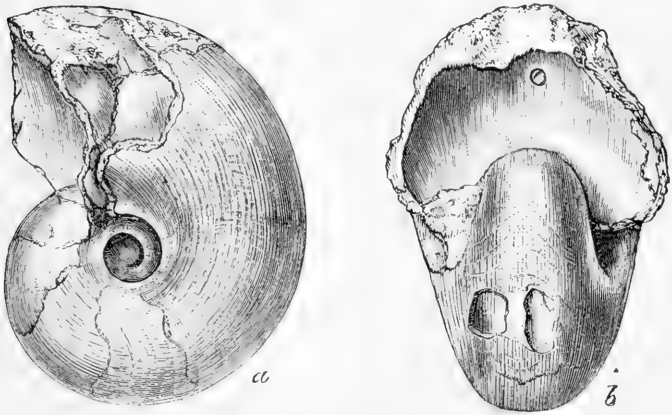
Horizon. Upper Lias.

Locality. Fontaine-Étoupe-Four (Calvados), France.

LOWER OOLITE.

6. *Nautilus ornatus*, sp. nov.

Fig. 7.



Nautilus ornatus.—*a*, lateral view of a young shell, showing the open umbilicus and the ornamentation of the test; *b*, front view, showing the position of the siphuncle. Drawn from a specimen in the British Museum (no. 51952). About half natural size.

Sp. char. Shell inflated, rapidly enlarging; sides compressed, but somewhat inflated in the middle; periphery broad, flattened. Umbilicus of moderate size and exposing a portion of the inner whorls; sides steep, margin rounded. Septa rather distant, being $2\frac{1}{2}$ inches apart where the whorl has a height of about 6 inches. Siphuncle rather large, situated above the centre. The test is ornamented in the adult shell with a series of longitudinal flattened bands separated by incised lines; these bands are almost entirely confined to the periphery, very few of them extending to the sides of the shell; they number about thirteen to an inch. The whole of the test is covered with fine subregular lines of growth, which curve backwards on approaching the periphery, where they form a shallow sinus. In a young shell ($4\frac{1}{4}$ inches in diameter, see fig. 7) the longitudinal ornaments cover the whole surface of the test, and they are in the form of delicate irregularly-spaced ridges, with very fine lines occupying the interspaces. The ridges are more numerous on the periphery than on the sides of the shell.

Remarks. The adult characters of the ornamentation of this species have been drawn up from a gigantic specimen, 2 feet in diameter, which was found at Sherborne, Dorsetshire. This is probably one of the largest examples of *Nautilus* known; at least the writers have never seen any account of a specimen approaching it in size. A smaller one from the same locality (Sherborne) measures 11 inches in its greatest diameter; it is a cast of the septate part of the shell, together with a portion of the body-chamber. Fragments of the test with its characteristic ornaments adhere to the cast in one or two places.

This species, in respect to its ornamentation, bears some resemblance to *N. Jourdani* of the Upper Lias, but can be at once distinguished by its less angular whorls and the rounded margin of the umbilicus. The latter character also distinguishes it from *N. terebratus* from the same beds, whose ornaments, like those of the adult shell of *N. ornatus*, are almost entirely confined to the peripheral area. There are no other species known to us from the Inferior Oolite with which this form can be confounded.

Horizon. Inferior Oolite.

Locality. Near Sherborne, Dorsetshire.

7. *Nautilus lineatus*, J. Sowerby.

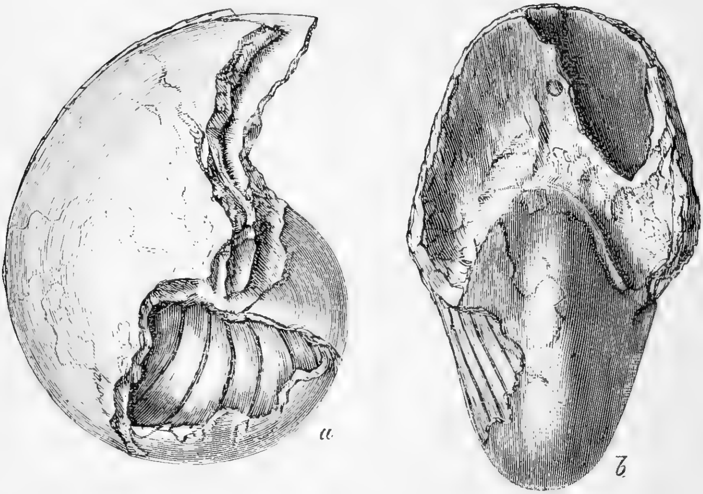
1813. *Nautilus lineatus*, J. Sowerby, Min. Conch. vol. i. p. 89, pl. xli.
? 1820. *Nautilites aperturatus*, Schlotheim, Die Petrefactenkunde, p. 83.

1821. *Nautilus lineatus*, Winch, Trans. Geol. Soc. vol. v. pt. ii. p. 555.
1830. *Nautilites lineatus* (?), Zieten, Les Pétrifications de Wurtemberg, p. 23, tab. xviii. figs. 2 *a–c*.
1832. *Nautilus lineatus*, Lonsdale, Trans. Geol. Soc. ser. ii. vol. iii. pt. ii. p. 272.
1835. *Nautilus lineatus*, Phillips, Geology of Yorkshire, pt. i. p. 129.
1836. *Nautilus lineatus*, Roemer, Die Verstein. des norddeutschen Oolithen-Gebirges, p. 179.
1840. *Nautilus lineatus*, Millet, Bull. Soc. Géol. de France, vol. xi. p. 365.
1845. *Nautilus lineatus*, Murchison, Outline of the Geology of the Neighbourhood of Cheltenham, new ed. p. 80.
1849. *Nautilus lineatus*, Quenstedt, Die Cephalopoden, p. 56, tab. ii. fig. 16.
1850. *Nautilus lineatus*, Lycett, Ann. & Mag. Nat. Hist. ser. 2, vol. ii. p. 412.
1852. *Nautilus lineatus*, Giebel, Fauna der Vorwelt, Band iii. Abth. i. p. 154.
1854. *Nautilus lineatus*, Morris, Cat. British Fossils, 2nd ed. p. 307.
1857. *Nautilus lineatus*, Etheridge, in Mem. Geol. Surv. Great Britain; Hull, On the Geology of the Country around Cheltenham, pp. 42, 48.
1858. *Nautilus lineatus*, Ooster, Cat. des. Céphalopodes Fossiles des Alpes Suisses, pt. iii. p. 8.
1858. *Nautilus lineatus*, Quenstedt, Der Jura, p. 284.
1858. *Nautilus lineatus*, Oppel, Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands, p. 366.
1860. *Nautilus lineatus*, Wright, Quart. Journ. Geol. Soc. vol. xvi. p. 40.
1860. *Nautilus lineatus*, Coquand, Synop. des Foss. Second. de la Charente, de la Charente-Inférieure, et de la Dordogne, p. 9.
1864. *Nautilus lineatus*, Ebray, Etudes Géologiques sur le Département de la Nièvre, fasc. 13, 14, p. 269.
1867. *Nautilus lineatus*, Waagen, Ueber die Zone des *Ammonites Sowerbyi* (Geogn. Paläont. Beiträge, Band i.) p. 590 (84).
1871. *Nautilus lineatus*, Phillips, Geology of Oxford and the Valley of the Thames, pp. 131, 164.
1875. *Nautilus lineatus*, Lepsius, Beiträge zur Kenntn. der Juraformation im Unter-Elsass, p. 26.
1879. *Nautilus lineatus*, Stoddart, Proceed. Bristol Naturalists' Soc. vol. ii. pt. iii. p. 279.
1880. *Nautilus lineatus*, Choffat, Étude Stratigraphique et Paléontologique des Terrains Jurassiques du Portugal, livr. i. p. 41.
1884. *Nautilus lineatus*, Mallada, Boletin de la Comision del Mapa Geológico de España, Sinopsis de las Especies Fósiles de España, vol. xi. p. 228 (figured *ibid.* vol. v. 1878, pl. iv. figs. 5, 6).
1884. *Nautilus lineatus*, Damon, Geology of Weymouth, Portland, and Coast of Dorsetshire, new ed. p. 220.
[Not 1842. *Nautilus lineatus*, d'Orbigny, Paléont. Franç., Terr. Jurass. vol. i. p. 155, pl. xxxi.]

Sp. char. "Flatted, spheroidal, umbilicate, surface obscurely striated, back flat, broad, with a concave line in the interior (which appears convex around the cast). Aperture rather square, deeply indented by the preceding whorl; septa numerous. . . . Diameter about one third longer than the thickness. The septa are very concave, with three slight waves in their margins. The siphunculus is near the middle of each septa" [septum] (*Sowerby*).

Remarks. The unsatisfactory character of Sowerby's description and figures of this species has given rise to much

Fig. 8.



Nautilus lineatus.—a, lateral view, showing the closed umbilicus, and parts of the septa where the test is broken away; *b*, front view, showing the position of the siphuncle and the compressed form of the shell. Drawn from a specimen in the British Museum (no. 43854 *a*), "Sowerby Collection." A little less than one half natural size.

confusion regarding its identity, and more than one species has doubtless been included under the name *lineatus*.

Though neither of the figured types of *lineatus* are contained in the British-Museum Collections, yet there is a specimen (one of those (a cast) numbered 43854) labelled in Sowerby's handwriting "*Nautilus lineatus*, M. C. 41," which agrees in all respects with his figures in the 'Mineral Conchology' (vol. i. pl. xli.). He, however, describes the species as "umbilicate," a statement which is not borne out by his figures; and we think it highly probable that Sowerby's figured specimens (which are both casts) had a closed umbilicus, because if the shell were present it would entirely fill up the cavity seen in the cast. Another specimen (cut and polished and also numbered 43854) is also labelled by Sowerby "*Nautilus lineatus*, M. C.," but it differs from his figured types in more than one particular, viz. in its more flexuous and less numerous septa, and in the siphuncle, which, instead of being near the centre, as in the type (lower figure of Sowerby's plate), is above. To this form we have therefore given a new name—*Nautilus pseudolineatus.*

Nautilus lineatus must now be restricted to shells of a somewhat robust habit of growth, with flattened sides and broad flattened periphery, closed umbilicus, numerous, very slightly flexuous septa, and a nearly central siphuncle. It may be added that the shell had a perfectly smooth surface.

The name *lineatus*, which was clearly intended by its author to have reference to the faint ridge seen upon casts along the median line of the periphery, has apparently misled many palæontologists, for we have seen in collections various Jurassic Nautili labelled "*lineatus*" which certainly belonged to more than one species. In point of fact this median line or ridge is the "Normallinie" of the Brothers Sandberger *, and cannot be used as a specific character, since it is found not only in numerous species of the Nautilidæ, but also in some species of the Orthoceratidæ.

The following species are evidently closely related, viz.:—*Nautilus lineatus*, *N. pseudolineatus*, sp. nov., *N. polygonalis*†, and *N. glaber*, sp. nov.

Horizon. Inferior Oolite.

Locality. Yeovil, Somersetshire. The specimen already referred to as bearing one of Sowerby's labels ("*Nautilus lineatus*, M. C. 41") is not localized.

8. *Nautilus pseudolineatus*, sp. nov.

Sp. char. Shell subcompressed, flattened upon the sides and periphery, the latter being moderately broad and having a subangular border. Umbilicus closed. Whorls about three, increasing rather slowly in diameter. Body-chamber occupying about half a volution; aperture wider than high. Septa rather deeply concave, nineteen or twenty in the last whorl, the last two very approximate. Sutures forming a sigmoid curve on the sides of the shell and a slight sinus on the periphery. Siphuncle rather large, subcentral. Test thick, smooth. Anterior border of muscular impression well defined, broadly arched (see fig. 9).

Remarks. The greatest diameter of the largest specimen in the Collection (no. C. 324) is $6\frac{1}{4}$ inches.

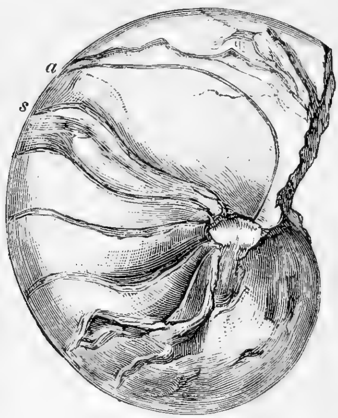
The slow rate of increase of the whorls in this species is

* 'Die Versteinerungen des rheinischen Schichtensystems in Nassau,' G. and F. Sandberger, 1850–56, p. 41.

† J. de C. Sowerby, Min. Conch. vol. vi. p. 56, pl. dxxx.

its distinguishing character. It is nearly allied to *N. lineatus*, Sow., but differs therefrom in its more distant and flexuous

Fig. 9.



Nautilus pseudolineatus.—Lateral view of a specimen, showing the closed umbilicus and several of the septa; *a* indicates the anterior border of the impression of the shell-muscle, *s* points to the last-formed septum. Drawn from a specimen in the British Museum (no. 69767). One third natural size.

sutures, more concave septa, the position of its siphuncle, and its slower rate of increase.

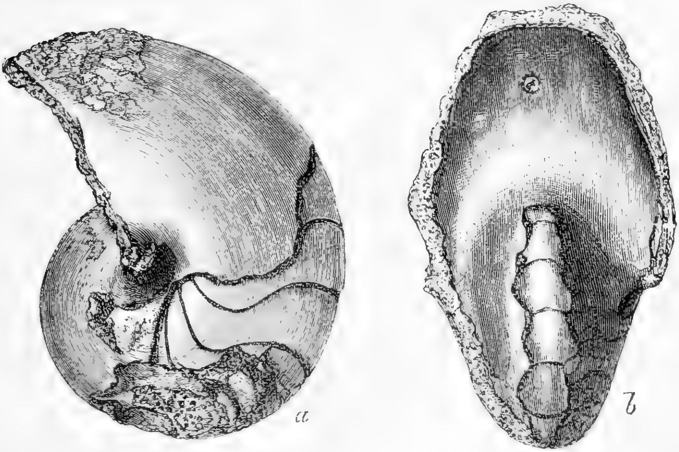
Horizon. Inferior Oolite.

Localities. Sherborne, Bridport, Burton-Bradstock, Dorsetshire; Yeovil, Somersetshire. A fine specimen—a section (no. C. 324 *b*)—is also recorded from Somersetshire, but from what place in that county is not known. Two specimens, numbered respectively 43854 (" Sowerby Coll.") and C. 2942, have no locality recorded against them in the register.

9. *Nautilus glaber*, sp. nov.

Sp. char. Shell completely involute, slowly increasing in diameter, compressed laterally, flattened on the periphery. Whorls wider than high, widest just above the umbilical region. Umbilicus completely closed. Septa moderately distant, shallowly concave; the sutures strongly bent backwards on the sides and very slightly sinuated upon the periphery. Siphuncle situated markedly above the centre. Surface of the test quite smooth. Body-chamber unknown. The larger specimen of the two representing this species in the British-Museum Collection measures about $5\frac{1}{2}$ inches in its greatest diameter.

Fig. 10.



Nautilus glaber.—*a*, lateral view, showing the closed umbilicus and some of the septa exposed by the removal of part of the test; *b*, front view, showing the position of the siphuncle and parts of the sutures where the test is broken. Drawn from a specimen in the British Museum (no. C. 2840). Rather less than half natural size.

Remarks. This species is nearly related to *N. pseudo-lineatus*, but differs therefrom in its compressed form, more distant septa, and strongly bent sutures, as well as in the more nearly marginal position of the siphuncle. It has also somewhat close affinities with *N. polygonalis*, J. de C. Sowerby *, especially in the curved form of its sutures and the position of its siphuncle. It may be distinguished from that species by its more compressed form, closer septa, and the siphuncle being further removed from the margin.

Horizon. Inferior Oolite.

Localities. Somersetshire; Bayeux (Calvados), France.

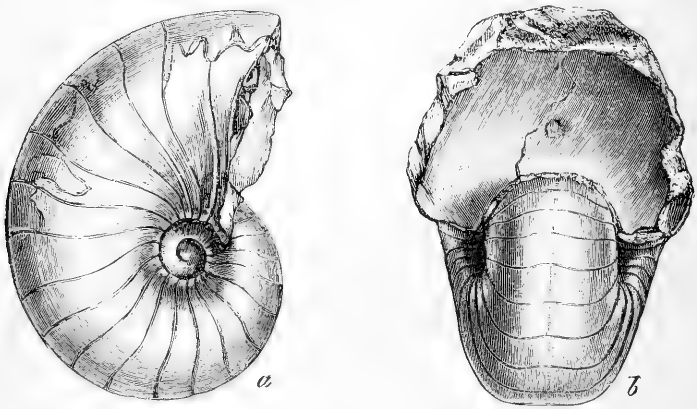
10. *Nautilus obesus*, J. Sowerby.

1816. *Nautilus obesus*, J. Sowerby, Min. Conch. vol. ii. p. 51, pl. cxxiv.
1832. *Nautilus obesus*, Lonsdale, Trans. Geol. Soc. ser. ii. vol. iii. p. 273.
1834. *Nautilus obesus*, Robert, Bull. Soc. Géol de France, vol. iv. p. 312.
1842. *Nautilus lineatus*, d'Orbigny, Paléontologie Française, Terr. Jurass. vol. i. p. 155, pl. xxxi. (not of J. Sowerby).

* Min. Conch. vol. vi. p. 56, pl. dxxx.

1845. *Nautilus obesus*, Murchison, Outline of the Geology of the Neighbourhood of Cheltenham, new ed. p. 80.
1852. *Nautilus obesus*, Giebel, Fauna der Vorwelt, Band iii. Abth. i. p. 165.
1854. *Nautilus obesus*, Morris, Cat. British Fossils, 2nd ed. p. 307.
1857. *Nautilus obesus*, Etheridge, in Mem. Geol. Surv. Great Britain; Hull, On the Geology of the Country around Cheltenham, p. 48.
1860. *Nautilus obesus*, Wright, Quart. Journ. Geol. Soc. vol. xvi. p. 40.
1871. *Nautilus obesus*, Phillips, Geology of Oxford and the Valley of the Thames, p. 164.
1873. *Nautilus obesus*, Sharp, Quart. Journ. Geol. Soc. vol. xxix. pp. 294, 299.
1879. *Nautilus obesus*, Stoddart, Proceed. Bristol Naturalists' Soc. vol. ii. pt. iii. p. 279.
1888. *Nautilus obesus*, Beeby Thompson, The Middle Lias of Northamptonshire, p. 54.

Fig. 11.



Nautilus obesus.—*a*, lateral view of a cast, showing the septa and the open umbilicus; *b*, front view, showing the position of the siphuncle. Drawn from a specimen in the British Museum (no. 39623). Rather more than one third natural size.

Sp. char. "Gibbose, umbilicate, plain; back broad, flat; mouth large, squarish; septa very numerous, not recurved; siphuncle nearly central. . . . Thickness about three fourths the diameter. The mouth is large, being two thirds the diameter long. The septa are very numerous; their angles not being recurved gives a very open form to the umbilicus. The siphuncle is transversely oval." (*Sowerby.*)

Remarks. We may add to this description that there is a specimen in the Woodwardian Museum from Bridport, Dorsetshire, on which the test remains; it is marked only with lines of growth. This shell is 4 inches in diameter.

This species appears to be most nearly allied to *Nautilus* *toarcensis*, d'Orbigny, but the latter is readily distinguished by its much thicker and broader shell, larger umbilicus, and more distant septa.

It is often a matter of very great difficulty to identify the species of *Nautilus* figured in the 'Mineral Conchology,' owing partly to the brief descriptions and partly to the figures being foreshortened, with the object of economizing space by showing as much of the specimens as possible in one view. Two views at least of each species are essential in order to give a correct idea of the form of the shell. There can be little doubt, however, that the specimens we have, after very careful comparison, referred to *N. obesus* are identical with Sowerby's fossil. Though the *type* specimen is unfortunately not in the "Sowerby Collection," there is an example in that collection labelled, probably by Sowerby himself, "*N. obesus*," which sufficiently agrees with the figure and description in the Min. Conch. to justify its reference thereto. Besides this individual there are several others both from England and France which, though young shells, possess unmistakably the characters of the present species. It is hoped that the figures here given of *N. obesus* may help to make it recognizable.

On comparing examples of this species from the Inferior Oolite of Courcy, Normandy, with d'Orbigny's figure of *Nautilus lineatus* *, we find that they agree remarkably well, and we have therefore placed the *N. lineatus* of d'Orbigny in the synonymy of the present species.

Horizon. Inferior Oolite.

Localities. Bath, Dundry, Somersetshire; Minchinhampton, Gloucestershire: Courcy, Normandy.

11. *Nautilus inornatus*, d'Orbigny.

1842. *Nautilus inornatus*, d'Orbigny, Paléontologie Française, Terr. Jurass. vol. i. p. 152, pl. xxviii.
1845. *Nautilus inornatus*, Murchison, Outline of the Geology of the Neighbourhood of Cheltenham, new ed. p. 91.
1849. *Nautilus inornatus*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. i. p. 245.
1857. *Nautilus inornatus*, Etheridge, in Mem. Geol. Surv. Great Britain; Hull, On the Country around Cheltenham, p. 27.
1858. *Nautilus inornatus*, Ooster, Cat. des Céphalopodes Fossiles des Alpes Suisses, pt. iii. p. 8.
1863. *Nautilus inornatus*, Day, Quart. Journ. Geol. Soc. vol. xix. p. 291.
1864. *Nautilus inornatus*, Eudes-Deslongchamps, Études sur les Étages Jurassiques Inférieurs de la Normandie, p. 83.

* Paléont. Franç., Terr. Jurass. vol. i. p. 155, pl. xxxi. figs. 1, 2.

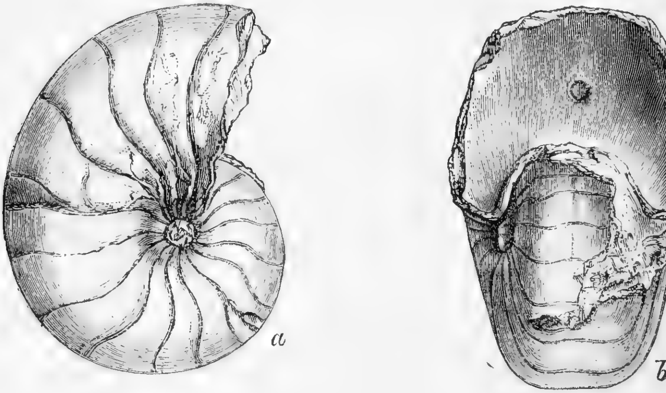
1871. *Nautilus inornatus*, Phillips, Geology of Oxford and the Valley of the Thames, pp. 131, 164.

? 1877. *Nautilus inornatus*, J. Buckman, Quart. Journ. Geol. Soc. vol. xxxiii. p. 2.

1879. *Nautilus* cf. *inornatus*, d'Orb., Branco, Der Untere Dogger Deutsch-Lothringens (Abh. zur geol. Specialkarte von Elsass-Lothringen), Band ii. Heft i. p. 57.

1884. *Nautilus inornatus*, Mallada, Bol. Com. del Mapa Geol. de España, Sinopsis de Fósiles de España, vol. xi. p. 228 (figured *ibid.* vol. v. 1878, pl. iii. figs. 5, 6).

Fig. 12.



Nautilus inornatus.—*a*, lateral view of a cast, showing the septa and very small umbilicus; *b*, front view, showing the siphuncle, "normal line," and the septa. Drawn from a specimen in the British Museum (no. C. 2843). Rather less than one half natural size.

Sp. char. Shell inflated, smooth, slightly umbilicated, flattened on the sides and periphery, making the section subquadrate, the greatest thickness being just above the umbilicus. Aperture wider than high. Sutures rather flexuous on the sides and curved backwards in crossing the periphery. There is a small dorsal (internal) lobe. Siphuncle a little above the centre. Body-chamber unknown.

Remarks. This species most nearly resembles *Nautilus obesus*, J. Sowerby, but it may be readily distinguished by its less robust shell, wider septa, and less open umbilicus, as well as by the slightly different position of the siphuncle.

The French specimen is a natural cast showing the sutures, siphuncle, and internal lobe, but the ornamentation of the inner whorl or young shell only is preserved. This consists of very fine lines of growth, crossed by fine, longitudinal, thread-like lines, the decussating sculpture characteristic of the young of *Nautilus*.

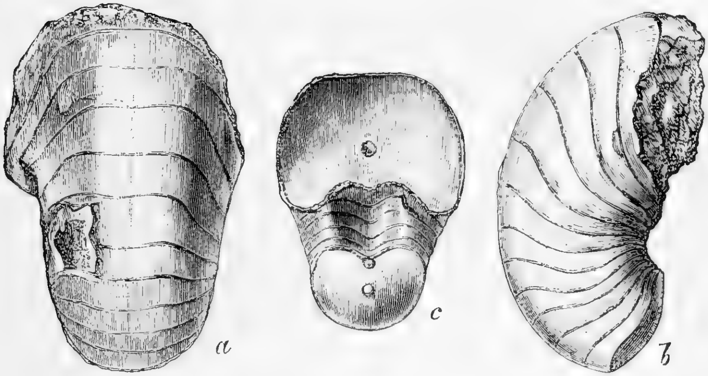
It is very doubtful whether the English references to this species are correct, because d'Orbigny's figure in the 'Paléontologie Française' does not correctly represent this species, a specimen of which from the d'Orbigny Collection we have had the opportunity of examining.

Horizon. Inferior Oolite.

Locality. Burton-Bradstock, Dorsetshire.

12. *Nautilus multiseptatus*, sp. nov.

Fig. 13.



Nautilus multiseptatus.—*a*, peripheral view of the septate part of the shell, showing the sutures and "normal line;" *b*, lateral view of the same; *c*, interior whorl of another specimen, showing the siphuncle and the inner (dorsal) lobe of the sutures. Drawn from specimens in the British Museum (no. 82379). *a* and *b* rather more than half natural size; *c*, natural size.

Sp. char. Shell compressed at the sides and somewhat flattened on the periphery, so that the whorls have a subquadrate section. Umbilicus open, of moderate size, with rather steeply sloping sides, probably exposing the inner whorls, but the specimens are not complete enough to determine the amount of enrolment. Septa very numerous, thirteen in about half a volution; sutures gently curved upon the sides of the shell and nearly straight upon the periphery. Internal (dorsal) lobe very conspicuous (see fig. 13, *c*). The cast is marked with a very distinct "normal line" along the median line of the periphery (see fig. 13, *a*). Siphuncle below the centre. Some detached body-chambers, probably belonging to this species, have portions of the test preserved, and this is quite smooth.

Remarks. This species appears to be nearly related to

Nautilus obesus (see fig. 11), but it is distinguished by its closer septa, the position of its siphuncle, its more slender whorls, and narrower periphery.

The specimens were all obtained in the Northamptonshire Ironstone, and from most of them the shell has been dissolved away, leaving hollow spaces surrounding the casts.

Horizon. Inferior Oolite.

Locality. Duston, Northamptonshire.

13. *Nautilus clausus*, d'Orbigny.

1842. *Nautilus clausus*, d'Orbigny, Paléontologie Française, Terr. Jurass. vol. i. p. 158, pl. xxxiii.
1849. *Nautilus clausus*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. i. p. 260.
1852. *Nautilus clausus*, Giebel, Fauna der Vorwelt, Band iii. Abth. i. p. 155.
1858. *Nautilus clausus*, Quenstedt, Der Jura, p. 350.
1858. *Nautilus clausus*, Chapuis, Nouv. Rech. sur les Foss. des Terr. Secondaires de la Province de Luxembourg (Acad. Roy. de Belgique, tom. xxxiii. des Mém.) pt. i. p. 14, pl. iii. fig. 1.
1860. *Nautilus clausus*, Wright, Quart. Journ. Geol. Soc. vol. xvi. p. 13.
1860. *Nautilus clausus*, Coquand, Synop. des Foss. Secondaires de la Charente, de la Charente-Inférieure, et de la Dordogne, p. 9.
1864. *Nautilus clausus*, Ebray, Etudes Géologiques sur le Département de la Nièvre, fasc. 13, 14, p. 270.
1868. *Nautilus clausus*, Dewalque, Prodrome d'une Description Géologique de la Belgique, p. 352.
1873. *Nautilus clausus*, Sharp, Quart. Journ. Geol. Soc. vol. xxix. p. 299.
? 1878. *Nautilus clausus*, Bayle, Explication de la Carte Géologique de la France, vol. iv., Atlas, pl. xxxvi.
1884. *Nautilus clausus*, Mallada, Boletin de la Comision del Mapa Geológico de España, vol. xi., Sinopsis de las Especies Fósiles de España, p. 228.

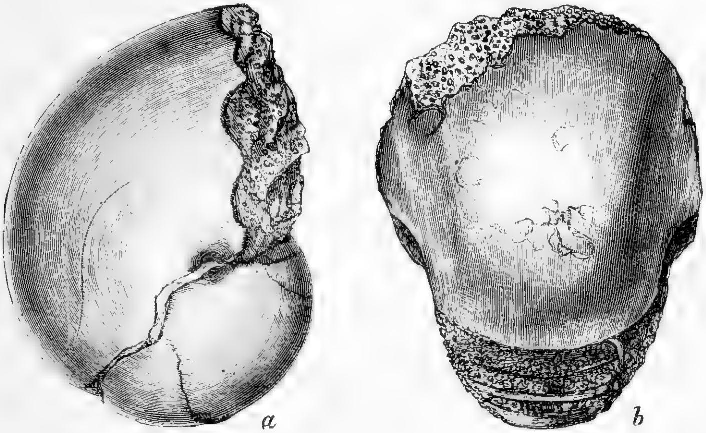
Sp. char. Shell inflated, rapidly enlarging, somewhat compressed on the sides, broad and flattened on the periphery; surface of test smooth or marked only with very fine subregular lines of growth. Whorls completely involute, widest in the region of the umbilicus, which is closed by a shelly callus. Aperture much wider than high. Septa slightly curved on the sides and forming a shallow sinus on the periphery. Siphuncle a little below the centre.

Remarks. This species bears some resemblance to *Nautilus subtruncatus*, Morris and Lycett *, and it is also like *N. Baberi* of the same authors; it differs from the former in its smooth test and from the latter in the same feature and also in its closed umbilicus.

* Mon. of the Mollusca from the Great Oolite, Pal. Soc. 1850, pt. i. p. 10, pl. i. figs. 1, 2.

We have lately had the great advantage of examining a specimen of the present species from the d'Orbigny Collection of the Museum of Natural History, Paris, and there is in

Fig. 14.



Nautilus clausus.—*a*, lateral view, showing the septate part of the shell covered with the test, and the cast of the body-chamber with part of the anterior border of the muscular impression, represented by the curved line; *b*, peripheral view, showing some of the septa at the lower part of the figure. Drawn from a specimen in the d'Orbigny Collection of the Museum of Natural History, Paris. About one half natural size.

the British Museum a good representative of it from Moutiers (Calvados). We have also seen a young specimen in the Woodwardian Museum, Cambridge, which appears to belong to this species; it is from Dundry, the only British locality mentioned by d'Orbigny. *N. clausus* is evidently rare in England, for it is not recorded in any of the papers on the geology of Somerset, by Etheridge, Tawney, and Stoddart; and Mr. E. Wilson has informed us that there are no examples of it in the Bristol Museum. Under these circumstances the determination of this species by Wright from Leckhampton Hill (Gloucestershire), and by Sharp * from the Northampton Sands, must, in the absence of descriptions and figures, be accounted of doubtful accuracy. The finest specimen of this species that we have seen is from Sherborne, Dorsetshire; it measures 9 inches in diameter and $6\frac{1}{4}$ inches in width.

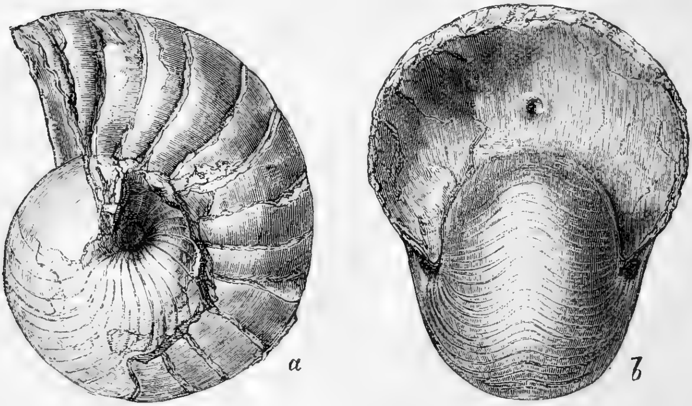
* For references to these authors' papers see the table of synonymy above.

Horizon. Inferior Oolite.

Localities. Dundry, Somersetshire; Sherborne, Halfway House, Dorsetshire.

14. *Nautilus perinflatus*, sp. nov.

Fig. 15.



Nautilus perinflatus.—*a*, lateral view of septate part of the shell, showing the small umbilicus, with a portion of the test; *b*, front view, showing the position of the siphuncle. Drawn from a specimen in the British Museum (no. 18398). Rather more than one third natural size.

Sp. char. Shell much inflated, very slightly flattened on the sides; peripheral area scarcely defined. Whorls semilunate in section, rather more than twice as wide as high, deeply embracing. Umbilicus very small. Septa rather approximate; sutures slightly curved on the sides of the shell and forming a shallow sinus on the periphery. Siphuncle near the inner margin. Test thick, marked only with lines of growth.

Remarks. This species closely resembles the *N. subinflatus* of d'Orbigny *, but differs in the position of its siphuncle and the greater size of the shell. Moreover, the examples upon which d'Orbigny's species was founded were obtained from the Kimmeridge Clay of Chatelaillon, near Rochelle (Charente-Inférieure), Honfleur (Calvados), and other localities, whereas the English specimens are from the Inferior Oolite of Bradford-Abbas, Dorsetshire, and Bristol.

* Prodr. de Paléont. Stratigr, 1850, vol. ii. p. 43; this species was originally called *inflatus* (Paléont. Franç., Terr. Jurass. 1842, vol. i. p. 165, pl. xxxvii.).

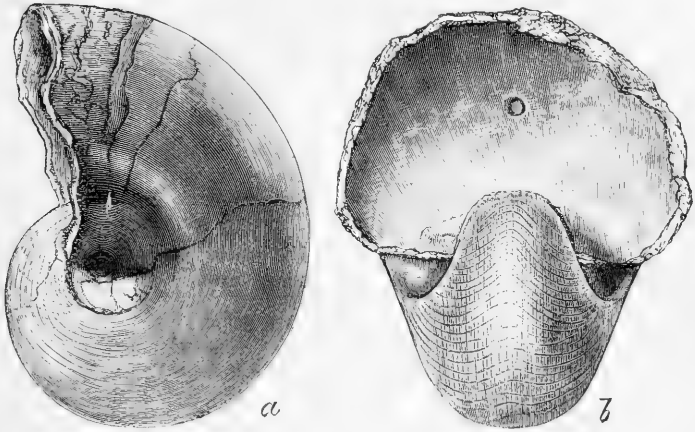
The largest specimen known to us is from the Inferior Oolite of Sherborne, Dorsetshire; its greatest diameter is 8 inches and greatest width $6\frac{1}{2}$ inches. Distinct traces of the anterior border of the muscular impression are observable on the cast of its body-chamber.

Horizon. Inferior Oolite.

Localities. Bradford - Abbas, Sherborne, Dorsetshire; Bristol, Somersetshire.

15. *Nautilus Smithi*, sp. nov.

Fig. 16.



Nautilus Smithi.—*a*, lateral view; *b*, front view, showing the ornaments of the young shell and also the position of the siphuncle. Drawn from a specimen in the British Museum (no. C. 747). About two thirds natural size.

Sp. char. Shell inflated, rapidly increasing, slightly compressed on the sides, broadly rounded on the periphery. Whorls much wider than high, widest in the region of the umbilicus. The latter is small, with a subangular margin and steeply sloping sides. The septa are rather distant from each other on the periphery, being half an inch apart where the height of the whorl is $1\frac{3}{4}$ inch. The sutures are but slightly curved on the sides and form a very shallow sinus on the periphery. The siphuncle is slightly above the centre. The test is ornamented with fine lines of growth, which tend to gather into obscure folds and form a deep sinus on the periphery; these are crossed by close-set longitudinal lines, more distinct in the young shell.

Remarks. The chief distinguishing character of this species is the subangular border of the umbilicus. In this last feature and also in the wide and semilunate section of the whorl this species resembles *Nautilus excavatus* *; but the latter has a much larger umbilicus and closer septa. It may also be compared with *N. Malherbi*, Terquem †; but the latter is at once distinguished by its less globose form and much larger umbilicus.

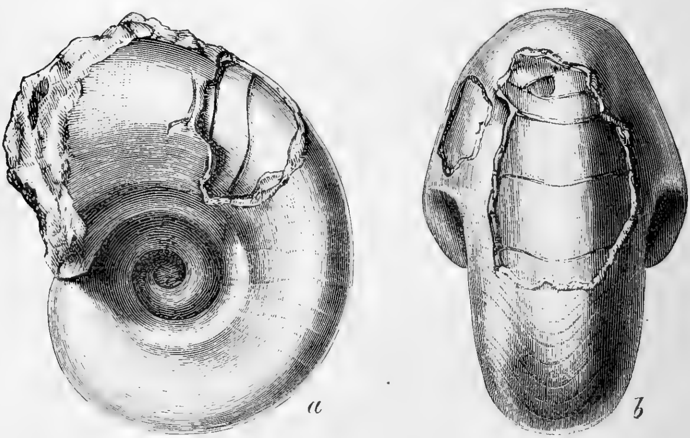
The type of this species (B. M. no. C. 747) is in the "Wm. Smith Collection;" hence the specific name. There is a fine example from Sherborne, Dorsetshire, in the Woodwardian Museum, Cambridge, in which the test is beautifully preserved. Two smaller ones in the same Museum are from Halfway House, Dorsetshire, and one shows the sculpture of the young shell perfectly.

Horizon. Inferior Oolite.

Localities. Burton-Bradstock, Halfway House, Bradford-Abbas, Dorsetshire. Two specimens in the British Museum (nos. C. 747 and C. 3095) are without localities, but are undoubtedly British.

16. *Nautilus burtonensis*, sp. nov.

Fig. 17.



Nautilus burtonensis.—*a*, lateral view, showing the large umbilicus exposing the inner whorls; *b*, peripheral view, showing some of the sutures where the test is removed. Drawn from a specimen in the British Museum (no. C. 2841). Somewhat less than half the natural size.

* J. de C. Sowerby, Min. Conch. vol. vi. p. 55, pl. dxxix. fig. 1.

† Mém. Soc. Géol. France, sér. ii. vol. v. pt. ii. 1855, p. 243, pl. xii. figs. 5, 5 *a*, 5 *b*.

Sp. char. Shell subglobose, compressed on the sides and periphery, the latter at first narrow and considerably flattened, but in the later stages of growth becoming wider and more rounded. The umbilicus is very large in proportion to the shell-diameter, its greatest width being $1\frac{1}{2}$ inches, while that of the shell is about 5 inches; it is moderately deep and exposes all the inner whorls, the sides slope steeply, and the outer border is subangular. The test, which is admirably preserved, is thick, and its surface is marked only with fine lines of growth, which make a deep sinus upon the periphery (see fig. 17, *b*). The septa are rather wide apart; the sutures slightly sinuous on the sides of the shell and forming a slight sinus on the periphery. In a young shell ($2\frac{1}{4}$ inches in diameter) the inner lobe is very conspicuous. The siphuncle is a little below the centre.

Remarks. This fine species is unlike any other known to us in the Jurassic rocks, but it bears some resemblance in the character of its umbilicus to the recent *Nautilus umbilicatus*, from which species it differs, however, in the proportionately greater size of its umbilicus and more flattened periphery.

Horizon. Inferior Oolite.

Locality. Burton-Bradstock, Dorsetshire.

Middle Oolite.

17. *Nautilus calloviensis*, Oppel.

? 1840. *Nautilus hexagonus?*, J. de C. Sowerby, in Grant's Fossils of Cutch, in Trans. Geol. Soc. ser. ii. vol. v. pt. ii. p. 329, pl. xxiii. fig. 4 (not of Sowerby).

1842. *Nautilus hexagonus*, d'Orbigny, Paléontologie Française, Terr. Jurass. vol. i. p. 161, pl. xxxv. figs. 1, 2 (not of Sowerby).

1858. *Nautilus calloviensis*, Oppel, Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands, p. 547.

1875. *Nautilus calloviensis*, Waagen, Mem. Geol. Surv. India, Palæont. Indica, Jurassic Fauna of Kutch, vol. i. p. 18, pl. iii. figs. 2, *a*, *b*.

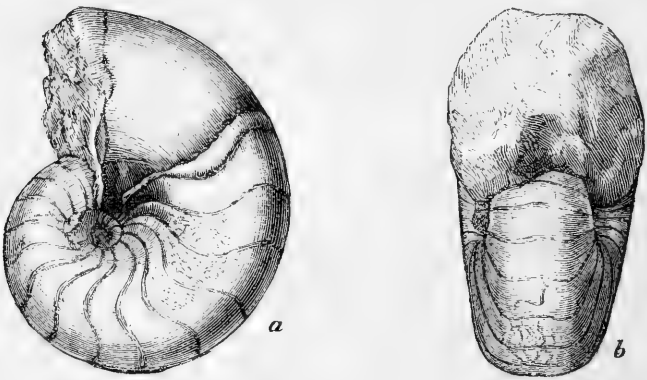
1884. *Nautilus calloviensis*, Lahusen, Mémoires du Comité Géologique [Russia], vol. i. no. 1, p. 42, Taf. iii. figs. 28, *a*, *b*, and 29, *a*, *b* (young).

1884. *Nautilus hexagonus*, Mallada, Boletin de la Comision del Mapa Geológico de España, Sinopsis de las Especies Fósiles de España, vol. xi. p. 229 (figured 1878, vol. v. pl. iv. fig. 9).

Sp. char. General form of the shell somewhat compressed, smooth, or marked only by faint, very fine, close-set lines of growth. The whorls are obtusely angular, flattened at the sides, and broadly truncated upon the periphery, the greatest thickness being at the umbilical margin. The umbilicus is very small. The septa form a sigmoid curve upon the sides of the shell and are slightly sinuous upon the periphery.

Siphuncle central. The ornaments of the test are described more exactly by Dr. Waagen * as follows:—"The shell itself is covered with two systems of fine striæ, of which the parallel ones, which follow the direction of the spiral, are limited to the external part of the shell. The others—striæ

Fig. 18.



Nautilus calloviensis.—*a*, lateral view of a cast, showing the septation and part of the body-chamber; *b*, front view. Drawn from a specimen in the British Museum (no. 88979). Nearly two thirds natural size.

of growth—cover the whole shell, are somewhat falciform on the sides, but bend strongly backward on the external part. On very large specimens these lines become very strong and numerous, and look as if cut in with a knife; the other system of striæ then entirely disappears. . . . On the cast the normal line is often very strongly pronounced."

Remarks. This species is rather near to *N. lineatus*, but it is distinguished by its more sinuous and approximate septa and narrower umbilicus.

The differences which separate the present species from *N. hexagonus*, J. de C. Sowerby, have been pointed out by that author in his description of the Kutch fossils collected by Captain Grant †. He says, "This [*N. hexagonus*?] differs from *N. hexagonus* in having a smaller umbilicus and in being more rounded."

Oppel distinguished this species from Sowerby's by its wider aperture; it may also be known by its deeply-lobed

* Mem. Geol. Surv. India, Palæont. Indica, Jurassic Fauna of Kutch, vol. i. p. 18.

† Trans. Geol. Soc. ser. ii. vol. v. pt. ii. 1840, Explanation of Plates.

sutures, in which character it approaches *Nautilus* (*Hercoglossa*) *franconicus*, Oppel.

Horizon. Calcareous Grit and Kelloway Rock.

Localities. Wiltshire; Marcham, Berkshire (Calcareous Grit). Scarborough, Yorkshire (Kelloway Rock).

XL.—*On the Dentition of* Pleuroplax (Pleurodus), *A. S. Woodw.* By James W. Davis, F.L.S.

[Plate XIII.]

In May 1879 * I described the teeth and spines of *Pleuroplax* (*Pleurodus*) *affinis*, Agass., occurring in a thin shale above the Better-bed Coal of Clifton and Lowmoor, near Halifax. A comparison of these spines with similar ones from the Staffordshire Coal-field, in the cabinet of Mr. John Ward, of Longton, showed them to be closely related. In connexion with one of the Staffordshire spines were a few fragments of teeth, referred with probability to the genus *Helodus*, and the inference was drawn that the two genera had similar spines.

Mr. Ward has just issued an admirable account of the North Staffordshire Coal-field †, in which he refers to the occurrence of numerous teeth of *Helodus simplex*, Ag., in association with a spine much resembling that of *Pleuroplax*, the full description of which he reserves to a future time. Mr. Ward also describes a specimen in his collection from the Northumberland Low Main Coal of the jaw of *Pleuroplax Rankinei*, Ag. It "is somewhat in the shape of a horseshoe, with a blunt rounded extremity, the articular ends expanded. Both rami support teeth, several of which unfortunately are displaced. Those in position are arranged upon the jaw with the lateral expansions pointing antero-posteriorly. The anterior teeth are relatively narrower than the posterior. The most posterior tooth, at least, has the summit of the crown crenulated."

Recently, whilst on a visit to Glasgow with my friend Mr. A. Smith Woodward, we found two specimens of *Pleuroplax* which prove not only that the two genera had similar spines, but that they are one species with the same spine. One of the specimens is from the University Museum, Glasgow, and

* Quart. Journ. Geol. Soc. vol. xxxv. p. 181, pl. x. figs. 1–11.

† "The Geological Features of the North Staffordshire Coal-fields," by John Ward: Trans. N. Stafford. Inst. of Mining and Mechanical Engineers, vol. x. (1890).

has been lent to me by Professor John Young; and for the second I am indebted to Mr. James Thomson, of the same city. The former, represented on Pl. XIII. fig. 1, exhibits the anterior portion of the body of the fish; the head, consisting of a mass of cartilaginous or chondroid substance, occupies nearly one half of the part preserved. The mouth, with teeth scarcely at all displaced, is well defined, the mandible is large, the upper jaw is not so easily distinguishable from the other elements of the cranium; the anterior extremity of the snout is unfortunately absent, but sufficient remains to show that the head was large and broad. A hollow above the posterior teeth of the jaws may indicate the position of the orbit. The whole of the surface of the head, together with the remainder of the body, is covered with glistening dermal tubercles or shagreen. The teeth are numerous, and, so far as can be identified, are arranged in shark-like concentric rows. Those occupying the posterior surface of the jaws are the teeth hitherto known as *Pleurodus*, whilst the anterior teeth, far larger in number, are those styled *Helodus* or *Lophodus*. The front teeth are pointed and adapted for seizing and holding prey, whilst those behind gradually assume broader and more massive proportions, and apparently in the palatal teeth of the Pleurodont type there is evidence of the ankylosing of three or four teeth together. The teeth occupying a median position in the jaws have their longer axis in the same line as that of the jaw, with the result that the Lophodont or Helodont teeth present an external cutting-surface, which resembles, when a pair of teeth is taken separately, the dentition of some of the Petalodonts (fig. 1 *a*). The head viewed from the front side, where the matrix is fractured, is seen to be squeezed over towards the exposed surface, and the opposite rami of the jaws can be traced along the edge of the matrix. The length of the rami of the jaws is 0·03 m.; at a distance of 0·025 m. behind the extremity of the jaw is a spine which has apparently been displaced; it is 0·040 m. in length and 0·010 m. in breadth, and, pointing towards the head, the spine extends in a diagonal direction with the base towards the dorsal aspect of the fish. Its position appears to indicate that it was located immediately behind the occipital region of the head.

Mr. Thomson's specimen does not exhibit the teeth *in situ* in the jaws, but in a slightly segregated form on the slab; in this respect it forms an extremely valuable companion to the specimen already referred to, because the relative size and form of the teeth are better seen. There are six teeth exposed of the Pleurodont type and near sixty teeth may be counted of the Helodont type. A representation of the slab is given on Pl. XIII. fig. 2, and drawings of the teeth, natural size and enlarged, are also given (figs. 2 *a*–2 *g*). The surface of all the teeth is enamelled and ornamented by minute punctures, indicating the superficial extremity of the nutritive canals.

These specimens are important as affording positive evidence of the structure of another group of Cochliodonts. Until the description of the dentition of *Psephodus magnus* by Traquair * was rendered possible by the discovery of the East-Kilbride specimen, very little reliable information respecting this family was accessible. The dentition of *Pleuroplax* as exhibited in these specimens confirms the opinion expressed by Traquair that the teeth of the genus *Lophodus* of Rowanowski were merely accessories in the dentition of other genera; and the statement of Sir R. Owen † in 1867, "that it would seem as if the several teeth of each oblique row in *Cestracion* had been welded into a single dental mass in *Cochliodus*," may well be applied to the whole of the family of the Cochliodonts; the broad palatal teeth of *Pleuroplax* clearly indicate that their present form and construction is due to the ankylosis of the smaller series of teeth possessing the Lophodont character which still remain separated in the anterior parts of the mouth.

The occurrence of the teeth of *Helodus* on the slab from the Staffordshire Coal-field in conjunction with the spine of *Pleuroplax*, referred to in my paper ‡ on *Pleurodus affinis*, seems to point to the inference that *Helodus simplex* must also be considered a Lophodont and absorbed in other genera. This view is confirmed by Dr. Traquair §, who has pointed out that "a fine series of specimens of *Helodus simplex*, Ag., in the collection of Mr. John Ward, F.G.S., Longton, clearly shows that the teeth in this species have the form of '*Lophodus*,' that the entire dentition consisted of teeth generally similar in shape, and that the dorsal fins were armed with spines resembling those of *Pleurodus*." Mr. A. Smith Woodward ‖ restricts the genus *Helodus* to the type species *H. simplex*, Ag., "a genus still awaiting elucidation." He regards it as closely related to *Pleuroplax* both by the dentition and the dorsal fin-spine, and has no doubt that, in what-

* Geol. Mag. dec. iii. vol. ii. p. 340, pl. viii. (1885).

† Geol. Mag. vol. iv. p. 59.

‡ *Op. cit.* p. 182.

§ Geol. Mag. dec. iii. vol. ii. p. 344, 1885 (footnote), and vol. v. p. 84, 1888.

‖ 'Catalogue of the Fossil Fishes in the British Museum,' part. i. p. 171 (1889).

ever family *Pleuroplax* be placed, the type species of *Helodus* must follow. The difficulty in associating the two genera is stated by Woodward to be that "in all known examples of the last-named genus (*Pleuroplax*) all the teeth are described as fused into plates, while in the typical *Helodus* no such arrangement has been discovered." This difficulty is removed by the discovery of the examples now figured.

EXPLANATION OF PLATE XIII.

Fig. 1. Anterior portion of body with head of *Pleuroplax*, showing position of mouth with teeth *in situ*, nat. size.
Fig. 1 *a*. Front view of the same specimen, exposed on margin of slab.
Fig. 1 *b*. Teeth from the median portion of the upper and lower jaw in juxtaposition, enlarged 4 diam.

Formation and Locality. Shale under the Drumgray Coal, Airdrie.
Ex Coll. Rankine Collection, University Museum, Glasgow.

Fig. 2. Group of teeth of *Pleuroplax*.
Fig. 2 *a*. Large posterior tooth, enlarged 2 diam.
Fig. 2 *b*. A second example, also from posterior part of jaw, × 2 diam.
Fig. 2 *c*. External and lateral aspect of a median tooth, with the former magnified 2 diam.
Fig. 2 *d*. External and surface aspects of a median tooth, × 2 diam.
Fig. 2 *e*. A tooth with deep root, × 3 diam.
Fig. 2 *f*. Side view of a tooth similar to fig. 2 *e*, × 3 diam.
Fig. 2 *g*. An example of a more elongated or attenuated tooth, × 3 diam.
Fig. 2 *h*. Tooth with a prominent crown; the lateral extension of the base greatly prolonged on one side, very short on the opposite one, × 3 diam.

Formation and Locality. Black-band Ironstone, Airdrie.
Ex Coll. James Thomson, Esq., F.G.S.; private collection.

XLI.—*Evidence of a Fossil Tunny from the Coralline Crag.* By A. Smith Woodward, F.G.S., F.Z.S.

M. Raymond Storms, of Brussels, who has long been engaged in studying the osteology of the Scomberoid Fishes, has lately published* some interesting observations on the vertebral column of the typical genera of that family, resulting in the determination of a series of large fossil vertebræ from the Scaldisian Pliocene formation in the neighbourhood of Antwerp. These fossils indicate a fish of very large size, and agree precisely with the corresponding vertebræ of

* R. Storms, "Sur la présence d'un Poisson du genre *Thynnus* dans les Dépôts Pliocènes des Environs d'Anvers," Bull. Soc. Belge Géol., Paléont., Hydrol., vol. iii. (1889), pp. 163–178, pl. vii.

Thynnus so far as they are distinguished from those of the known allied genera. Some slight differences, however, are observable when comparisons are instituted with the vertebræ of the two larger existing Tunnies (*T. thynnus* and *T. germo*), and, though these distinctive features cannot be exactly formulated, M. Storms decides to apply the provisional name of *Thynnus scaldisiensis* (*scaldisii*) to the Pliocene fish until sufficiently complete examples are discovered for precise specific definition.

Full details of the characters by which the various vertebræ of *Thynnus* may be recognized are given in the memoir just quoted, and it is thus unnecessary to enumerate them here. The object of the present note is merely to remark that vertebræ closely resembling the Scaldisian fossils occur in the Coralline Crag of Suffolk; and, though these are of somewhat smaller size, it will be convenient to record them under the same name—*Thynnus scaldisiensis*—until further and more satisfactory evidence of the species is forthcoming.

A hinder caudal vertebra of this form, from the Coralline Crag of Aldborough, was presented to the British Museum by Mr. Searles V. Wood, F.G.S., many years ago, and has long been labelled "Vertebra of a Scomberoid Fish" by Mr. William Davies. This specimen most nearly resembles the two vertebræ represented by M. Storms, *loc. cit.* figs. 20, 21, and is almost in the same state of preservation, though the lamellar transverse processes are more completely broken away; in proportions it appears identical, but in size it is somewhat inferior, the length of the centrum being only 0·044, its breadth 0·047, and its depth 0·035 m.

A second vertebral centrum referable to the anterior portion of the caudal region has lately been obtained by the British Museum (no. P. 5583) from the Crag of Suffolk, and, though the precise locality is unrecorded, the mineral condition of this fossil resembles that of the foregoing so completely, that it may probably be assigned to the same horizon. The specimen agrees most nearly with figs. 12 and 19 of Storms, which represent the thirtieth vertebra of *T. thynnus* and *T. scaldisiensis* respectively; it resembles the first in the position of the inferior vascular foramen, but corresponds more closely with the second in the slenderness of the middle part of the ridge between the lateral fossæ. The centrum measures 0·038 m. in length, 0·039 in breadth, and 0·032 in depth, and the base of the characteristic hæmal arch is indicated, while the neural arch is entirely destroyed.

Other Scomberoid caudal vertebræ, more imperfectly preserved and having the appearance of derived fossils, occur in the Red Crag of Woodbridge (Brit. Mus. nos. 43328, P. 5582). These are more laterally compressed than the vertebræ of *Thynnus scaldisiensis*, and differ remarkably in the stouter and broader proportions of the ridge between the lateral fossæ. Discoveries in the Eocene render it probable that these fossils represent some early Tertiary genus at present undetermined.

XLII.—*Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland)*.—No. XI. By Prof. M'Intosh, M.D., LL.D., F.R.S., &c.

1. On the Occurrence of the Hydromedusæ and Scyphomedusæ throughout the Year.
2. On *Arachnactis*.

1. *On the Occurrence of the Hydromedusæ and Scyphomedusæ throughout the Year.*

In examining the Medusæ three nets were often used simultaneously, viz. surface, midwater, and bottom, and no special apparatus was at any time employed for the closure of the two latter during descent and ascent. Fairly reliable observations, however, were made with regard to the bathymetrical distribution of these pelagic organisms without the latter arrangement, as proved by the fact that each net occasionally had a fauna of its own, and that, as the season advanced, certain forms which at first were near the bottom appeared by-and-by in the midwater- and finally in the surface-net. In August 1888, for instance, the surface-net was less rich in species of Hydromedusæ than either of the others, though certain forms occurred in great abundance, a transference of the latter from the lower regions of the water having taken place.

It is possible that some of the forms subsequently mentioned may pertain to the same Hydroid stock, representing perhaps younger and older stages or mere variations; but as our knowledge of the group, though largely added to by the labours of Allman, Agassiz, Hæckel, Hincks, and others, is still in need of improvement, it has been considered advisable to follow to a certain extent the descriptions of Forbes. No gonozooid of *Corymorpha*, which occurs in considerable numbers on smooth ground off the Budda Rock, has yet been obtained.

In contrasting in August the fauna of the bay with the offshore in the neighbourhood of the Bell Rock, the greater abundance of *Lizzia octopunctata* and *Lizzia blondina* in the latter area is noteworthy. Moreover, small specimens of *Bougainvillia britannica* were abundant in the open water. Minute Medusa-buds were common to both areas, as also were *Thaumantias inconspicua*, *T. hemisphærica*, and *T. melanops*.

The importance of the Medusæ in regard to the fisheries rests mainly on the vast number of ova and the resulting free planulæ which they produce, for both largely increase the food-materials for larval and early post-larval fishes, as well as for the Invertebrates on which they and the somewhat older stages feed.

In the laborious work of examining the various nets throughout the year I have to acknowledge the skill and steady perseverance with which Mr. Pentland Smith, M.A. (now of the Horticultural College, Swanley), aided me.

Oceania (*Tiara*) *octona*, Fleming, first appeared in the bottom-net in March. In August it was often procured in the midwater-net and in a ripe condition, while in September both large and small specimens were common; some were ripe. Since Dr. Fleming found the species in this neighbourhood in 1821 it has occurred all along the eastern coast. *Oceania conica* is ripe at Naples in March, while *O. pileata* is mature in January.

Oceania episcopalis, Forbes.

An example about $\frac{1}{4}$ inch in diameter occurred in the midwater-net in the middle of June. It seems to be much less common than the preceding species. It was found by Forbes on the western fishing-banks of Shetland in 1845, the largest reaching $1\frac{1}{2}$ inch in diameter.

Oceania globulosa, Forbes.

In the midwater-net in August and once in September. Forbes procured his examples in Bressay Sound, Shetland, in 1835.

Besides the foregoing an *Oceania* was captured in August with only one yellow tubercle (instead of three) between the tentacles, with pinkish ocelli and ovaries, and quite mature. In other respects it resembled *O. octona*. Another had no tubercles between the tentacles, which were in four groups, five in each, and with two additional. The ocelli and ovaries resembled those of *O. octona*.

Bougainvillia britannica, Forbes (*Margelis ramosa*, Agassiz).

A single example appeared in the midwater-net in March; in May only once, in small numbers. It occurred almost daily in June in the midwater-net, and of variable size. None were quite ripe. A single large immature specimen was captured in July; and it was comparatively scarce in August, though towards the end of the month it was ripe. Many small examples frequented the open water beyond the bay. Throughout September it occurred in small numbers, and many were ripe.

It is common round the British shores. Prof. Allman* observes that the gonosome is developed in autumn. Lo Bianco† states, on the authority of Du Plessis, that this Hydromedusa appears in winter and spring in the Bay of Naples.

The polyparies are found off St. Andrews Bay and the neighbourhood of the Forth.

Bougainvillia nigritella, Forbes.

Small specimens were captured in the bottom-net in April and comparatively large examples in the midwater-net in August. Ripe forms occurred once or twice in September. Forbes found it in Bressay Sound, Shetland, in the autumn of 1845.

Lizzia octopunctata, Sars, was first captured in the bottom-net in March, in the midwater-net in April, when the specimens also had buds, and only once in May. One or two examples were obtained during the first half of June. In August again it appeared in the surface-net.

It seems to be most frequently procured in early spring, and is generally distributed along the eastern coast. Forbes found it on both sides of Shetland. It is not an abundant form in the bay, and it ranges from $\frac{1}{15}$ to $\frac{1}{10}$ inch in diameter.

L. octopunctata is an active and voracious form, engulfing the bodies of Appendicularia, while the tails project as singular appendages to the Medusa, and the same happens to small Sagittæ, the end being fixed in the manubrium, and sometimes the umbrella is everted.

At Naples *L. Köllikeri*, Gegenb., is ripe in March.

Lizzia blondina, Forbes.

Procured on the ground near the Bell Rock in August. It was formerly obtained by Forbes in the Zetlandic seas.

* 'Gymnoblastic or Tubul. Hydroids,' p. 312.

† Mitth. Z. Stat. Neapel, 8 Bd. p. 385 (1888).

Sarsia tubulosa (Sars), Lesson.

This species made its appearance towards the end of April, and a few attained half an inch in diameter. Throughout May and June it occurred in the midwater-net almost daily and of variable size, though many were small. All were immature. At the commencement of July all were in the latter condition, and small, but they became larger as the month advanced, comparatively few, however, being obtained at any given time.

In the Ann. & Mag. Nat. Hist. for August 1887 the Hydroids which were reared from planulæ of *Sarsia* are mentioned, the species being *Syncoryne decipiens*, Dujardin. As this Hydroid is not common in the Bay of St. Andrews, these Medusoids probably were carried by currents from the estuary of the Forth and the neighbourhood ; yet they were in great numbers, penetrating all the nooks of the bay, and passing far up the estuary of the Eden.

Forbes chiefly found this form in June and July off the coasts of Ireland and Shetland. It is very generally distributed, however, along the eastern shores and probably also on the western.

Sarsia (*Codonium*) *pulchella*, Forbes.

Obtained in May. It has a greenish tinge at the oral extremity. The relations of this form require elucidation.

Syncoryne eximia, Allman.

The gonozooid of this form was captured in May.

Stauridium productum, S. Wright.

Gonozooids procured in June and July. Lo Bianco gives October as the month for them at Naples.

Besides the foregoing, a gonozooid of *Podocoryne carnea*, Sars, occurred in July. Lo Bianco thinks this species at Naples sends off buds throughout the year.

Thaumantias pilosella, Forbes (*Laodice cruciata*, Agassiz), was captured sparingly in April and May, increasing in size as the latter month advanced, small specimens being most common in the former and the beginning of the latter month. In June swarms occurred in the midwater-net almost every day, and the individuals as a rule were somewhat larger than in the previous month, though not quite mature. They were nearly ripe in August. At the beginning of September many had attained $1\frac{1}{8}$ inch in diameter and were mature.

Forbes described *T. pilosella* only from Shetland and the south of England; but it is abundant all along the eastern shores.

In this species, as in allied forms, it is probable that after discharge of the reproductive elements the Hydromedusæ perish; they certainly disappear from the areas they previously frequented in myriads.

An undetermined form* was met with at the beginning and end of June, and often in great numbers in July, many having the male elements fully developed, but none had ripe ovaries. They were notable for their size ($1\frac{3}{8}$ inch in diameter). This species likewise occurred in the midwater-net in August and once in September. It differs from *Thaumantias pilosella* in the arrangement of the tentacles and the great length of the manubrium, which is proportionally almost as large as in *Tima*.

Thaumantias quadrata, Forbes.

An immature example occurred in the midwater-net in August. Forbes found it abundantly in the harbour of Tarbet, Loch Fyne, in the autumn of 1845. It would appear to be a late Medusoid.

Thaumantias octona, Forbes.

Numerous examples of this small form were captured in the middle of June. It also occurred in the surface-net in August. All were immature. Forbes procured it both at Oban and at Tarbet, Loch Fyne.

Thaumantias melanops, Forbes, came somewhat sparingly under notice in May, and, as in the former case, increased in size as the month advanced. It occurred in multitudes in the midwater-net in June, and on an average larger than during the previous month. One, $\frac{5}{16}$ inch in diameter, had fully-developed ova on the 13th of June. It was one of the most conspicuous Hydromedusæ in July, when it was fully mature. Some reached $\frac{3}{4}$ inch in diameter. While appearing almost daily in the midwater-net, it also towards the end of the month was found in the bottom-nets, though the specimens in these were small and immature. It occurred both in the midwater- and bottom-nets in August.

It is generally distributed along the eastern coast. Forbes procured it in Shetland.

* *Vide* Report of the Fishery Board for Scotland, ix. pl. v. figs. 6–9.

Thaumantias maculata, Forbes.

In June this form well illustrated the variability of a species in regard to maturity. Specimens were very numerous and very ripe on the 23rd, while those obtained on the 25th were immature. At the beginning of July they were almost ripe and fully half an inch in diameter, and a week or two afterwards others of the same size were mature. This variability in regard to maturity probably depended on the stage of growth of a particular series, which it may be was swept by currents into the bay.

Forbes found this Hydromedusa several times in Bressay Sound, Shetland. It was never plentiful.

Thaumantias gibbosa, Forbes.

Many examples apparently of this form were procured in the midwater-net on the 13th and 18th June.

Forbes captured it in the Hebrides.

Thaumantias pileata, Forbes.

A few specimens referable to this species were procured at the beginning of June.

It was discovered by Forbes at Portrush, on the north coast of Ireland, in June 1839.

Thaumantias hemisphœrica (Gronovius), O. F. Müller.

This, perhaps, is the most conspicuous of the group both in regard to size and numbers in June, and it is often stranded on the West Sands in great profusion, and nearly 1 inch in diameter. Moreover it has an additional interest, since it is frequently selected by the larval *Peachiœ* for attachment by the widely open mouth and tentacles. The young anemones are thus carried about without effort on their part, and obtain some of the advantages of the *Arachnactis*-stage of *Edwardsia*. *T. hemisphœrica* reached full maturity this month. During July it was in great profusion in the midwater-net and occasionally appeared in the bottom-net; and since the latter feature did not occur previously, it may be presumed that it was not entirely due to the capture of the Medusoids on the way up. Larval anemones (*Peachiœ*) now considerably larger still adhered to this species and to *T. melanops*, occupying diverse positions, as on the outer surface at the margin of the base or on the manubrium. The Hydromedusæ were also often fully ripe. Some of the larger exceeded ¾ inch.

Small examples were common in the bottom-net in August, both inshore and offshore, as in the neighbourhood of the Bell Rock. Mature specimens again were numerous in the midwater-net, many having larval *Peachiæ* attached to them both in and beyond the bay, though perhaps they were most numerous within the limits. In the surface-net it occurred in limited numbers and in full maturity with many free ova.

The numbers were not much diminished throughout September and the majority were ripe. In the earlier part of October many were mature, others nearly so. Many occurred in the midwater-net during the first half of the month, and they ranged on each side of $\frac{5}{8}$ inch. Even in December a few examples were captured in the midwater-net.

The species appears to be common all round the shores of Britain, as well as in the North Sea generally.

Thaumantias lucifera, Forbes.

Minute specimens were found in the bottom-net in March. It also occurred sparingly in May, while in June great numbers were met with at the beginning and end of the month. It was generally under $\frac{1}{4}$ of an inch. It appears to be generally distributed round the British shores.

Phialidium variabile (= *Thaumantias globosa* &c., Forbes) was captured sparingly in May and June in the midwater-net. Its size ranged from $\frac{1}{4}$ inch in diameter downwards. None were quite mature.

The same species in the varieties *globosa*, *convexa*, and *sarnica* appeared in the midwater-net in August, as well as in the bottom-net—chiefly at the beginning of the month.

Forbes limits its occurrence to Shetland, on both sides of which it was found plentifully in the harbours. It seems to have a wide range on both eastern and western shores of Scotland.

Phialidium variabile, var. *inconspicua*, Forbes, occurred in considerable numbers several times about the middle of June. All examined were immature, and none exceeded $\frac{1}{4}$ inch in diameter. It was in full maturity in August, abounding in the bottom-net at the beginning of the month, while comparatively few were got in this net towards the end. It also appeared in the midwater- and surface-nets.

Forbes procured this form in the Hebrides.

Besides the foregoing a few examples of a *Thaumantias* appeared in the midwater-net in February and April. In the same net a small form was procured on the 24th May which does not seem to correspond with anything named. It had numerous brick-red and comparatively large ocelli.

It is no wonder that the Medusoids of this type are so abundant in St. Andrews Bay, since *Obelia*, *Clytia*, and the Campanularians are so common.

Clytia Johnstoni.

The gonozooids are characteristically plentiful in April, issuing from the stock in swarms. Moreover the old polypites and thecæ were thrown off and new ones reproduced. Lo Bianco observes that at Naples the formation of the Medusoids occurs in the gonophores from October till March, while the free Medusoids are procured in January.

In July numerous minute Medusoids, some probably pertaining to *Obelia*, were captured in the bottom-nets. They had perhaps only recently gained freedom, and, along with the various planulæ, frequented the lower regions of the water. Medusoids are very common all round the British shores during this month, and the water is sometimes rendered phosphorescent by the swarms from *Obelia* alone. These frequently occur at the surface as well as throughout the water.

Tima Bairdii, Johnst.

In January specimens were captured fully 2 inches across and almost colourless, the peduncle alone showing a whitish tip, with a faint brownish hue at the base of the tentacles. The reproductive elements were well advanced, so that the spawning-period could not be far distant. Only a single small example was procured in February in the midwater-net. In May a few comparatively young specimens also were obtained. It is noteworthy, however, that no very small examples have been seen, though occasionally in its earliest phases it may have escaped observation or have been confounded with other forms, especially as the young is unlike the mature form. Only two small examples, one within and one without the bay, were got in August. Both small ($\frac{3}{4}$ inch) and fairly grown forms (about $1\frac{1}{2}$ inch) appeared in the midwater-net in September, as also the small abnormal one formerly described *. All were immature. The same remarks apply to October, the largest, however, being only $1\frac{1}{4}$ inch in diameter. In December *Tima* reached its maximum size, a specimen fully 3 inches across being captured in the midwater-net. A few of medium

* *Vide* Ann. & Mag. Nat. Hist. January 1890, p. 41.

size were also procured in the surface-net. The reproductive organs were well developed, but not quite ripe. This month and January would appear to be the period during which these Hydromedusæ as a rule reach full maturity. Lo Bianco states (*fide* Chun) that the ova of *Tima flabellaris* are ripe in October.

This form was first observed by Dr. Johnston, of Berwick, in 1833, and shortly after by Edward Forbes on the West Sands at St. Andrews. It abounds all along the eastern shores of Britain to the estuary of the Thames.

The Hydroid stock from which *Tima* springs is not well known, though Hæckel gives *Lafoëa* and *Campanularia* for the group. Louis Agassiz had formerly raised the Campanularian zoophyte from an American *Tima*.

Willia stellata, Forbes?

Another gonozooid 2·5 millim. in diameter presented a somewhat globular umbrella with twenty-four large purplish tentacular bulbs, from which proceeded as many slightly pinkish tentacles. The subumbrella reached nearly to the tip of the umbrella. The lips of the peduncle were produced into four branched filiform processes. The four double ovaries were filled with large orange-red ova, apparently ripe.

Melicertum (*Stomobrachium*) *octocostatum*, Sars, appeared in the midwater-net in January, and thereafter disappeared till August, when small numbers were captured once in the same net. It occurred sparingly once or twice in September and of good size. Throughout October similar specimens were occasionally met with in considerable numbers. None were mature. It was somewhat plentiful in the surface-net at the commencement of December, and a few, $\frac{1}{2}$ inch in vertical diameter, likewise were got in the midwater-net. This form appears to attain full size at St. Andrews. Forbes did not frequently meet with this common species.

Circe rosea, Forbes, was present in great numbers in January, not only in the bay but far out at sea, and at surface, midwater, and bottom. Vast numbers continued throughout February in the midwater-net and smaller numbers in the surface- and bottom-nets. Many young specimens were present. In the large forms the reproductive organs showed numerous clear cells. In March they were still very abundant in the midwater- and bottom-nets, and the majority were full-grown, though small forms were also mingled with them. *Circe* attained full growth in April; indeed no larger forms were seen, and the reproductive organs were well develop ed The species then disappeared till November, when it occurrh- in considerable numbers, though none were large. Througut out December it appeared sparingly in the surface-net, b. of somewhat larger size than in the previous month; while in the midwater-net it was in profusion, the larger forms being about $\frac{5}{8}$ inch, the smaller less than $\frac{1}{4}$ inch. The reproductive organs were fairly developed. This species and *Pleurobrachia* occurred in three out of four hauls in the bottom-net. *Circe* thus forms one of the features of the pelagic fauna during the winter months.

Forbes found the species only in the Zetlandic seas in 1845. It is, however, abundant off the east coast of Scotland. L. Agassiz, again, mentions that he procured the American form only in July. Forbes points out the difference of his species from Brandt's in regard to the eyes, which are absent; but A. Agassiz observes that what Forbes took for ocelli in Brandt's figure are only sections of the chymiferous tubes.

Scyphomedusæ.

Minute ephyræ about $\frac{1}{30}$ inch in diameter appeared in the bottom-nets towards the latter third of February. Swarms again occurred in March in the same region. A wealth of Medusoid life is found close to the bottom at this season. In May considerable numbers of young *Aureliæ*, ranging from $\frac{1}{8}$ to $\frac{1}{2}$ inch in diameter, were captured. As the month advanced they increased in size, and the contrast was still greater when placed side by side with the minute forms procured in March. Young *Aureliæ* and *Cyaneæ* are often beached on the sands in May. In July (1888) the adults were comparatively rare, a condition unusual in ordinary seasons. Thus only a young example $\frac{1}{2}$ an inch across was found in the midwater-net at the beginning of the month and a few larger in the same net on the 19th. As a rule the immense numbers of these forms prove troublesome in the trawl- and other nets both from their stinging-powers (*Cyanea*) and their weight.

In regard to *Cyanea* a single example $\frac{3}{8}$ inch across the disk was procured in June, and only once were a few specimens 7 or 8 inches in diameter stranded on the sands (June). In former years not only did this form and *Aurelia* abound at the surface of the bay in July, but far out at sea. It would seem that warm sunny weather is connected with the presence of these and other marine forms at the surface. It is worthy of note that once in January a large example was procured by the trawl in deep water and at a considerable distance from the shore—a solitary survivor of the hosts of autumn.

2. *On* Arachnactis.

In the Zetlandic seas no more conspicuous form than *Arachnactis* occurs amongst the pelagic animals in July. It is, however, by no means common along the eastern shores of Scotland, so far as present experience goes. At Plymouth, again, Mr. Harmer stated at the meeting of the British Association at Newcastle that it was abundant. Its comparative rarity in the Bay of St. Andrews is peculiar, since *Edwardsiæ* are by no means unfrequent; indeed, the stomachs of some Pleuronectids are filled with them. The only example yet observed at St. Andrews is a minute form about $\frac{1}{8}$ inch in diameter which was captured in the midwater-net on the 11th June amongst Hydromedusæ and other Cœlenterates. In lateral view (fig. 1) it somewhat resembles a cushion-star, and is more or less translucent, a faint tinge of yellowish existing only at the tips of the tentacles. Of the latter, four are conspicuously larger than the rest, three a little shorter, while two tentacle-buds occur opposite the median one (fig. 2). The oral region shows two prominent papillæ, and the mesenteries, though apparently not quite complete, are well marked.

Fig. 1.

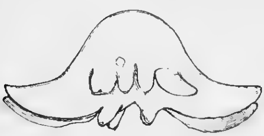
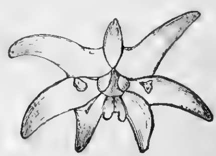


Fig. 2.



XLIII.—*British Fossil Crinoids.* By F. A. Bather, B.A., F.G.S., Assistant in the British Museum (Natural History).

[Plate XIV.]

I. *Historical Introduction.*

The fossil Crinoidea of the British Isles are of great interest to the zoologist, for in the early days of geology they attracted the attention of many enthusiastic workers and most of the common genera were established on the evidence of British specimens. The first work of any importance is James

Parkinson's 'Organic Remains of a Former World' (1811): his figures and descriptions, though both excellent and careful, were unaccompanied by names on the Linnean system; since, however, they were constantly referred to by Von Schlotheim in his 'Petrefaktenkunde' (1820), they are of importance in enabling us to identify the types of the German author. George Cumberland, of Bristol, the author of a paper in the 'Transactions of the Geological Society' (1819) and of 'Reliquiæ Conservatæ' (1826), is another whose work is liable to be passed over on account of its deficiency in systematic names; but, when we compare the completeness of description and the accuracy of draughtsmanship shown by these two early authors with the two lines and a half of dog-Latin diagnosis unelucidated by so much as a diagram that are nowadays thought enough to bear the weight of a specific name, then we shall not doubt for long which method is the more advantageous to science.

The morphology and classification of the group were first set on a satisfactory basis by J. S. Miller in 'The Natural History of the Crinoidea' (1821), where 11 genera, including *Encrinus*, *Pentacrinus*, and *Comatula* of former authors, and 26 species were described. J. Phillips, in the 'Geology of Yorkshire' (1836), originated many names of both species and genera; while three years later the same author revealed in Murchison's 'Silurian System' the existence of many types previously unknown. The British Devonian Crinoids alluded to by Sedgwick and Murchison and J. de C. Sowerby in 1840 were more fully described by Phillips in the 'Palæozoic Fossils of Cornwall &c.' (1841). The Carboniferous Crinoids of Ireland next received attention at the hands of R. Griffith (1842), J. E. Portlock (1843), and especially F. M'Coy (1844). 'The Synopsis of the Silurian Fossils of Ireland' by the last-named palæontologist, though bearing date 1846, does not seem to have been published till 1862. Meanwhile in 1842 T. and T. Austin had begun to publish in the 'Annals and Magazine of Natural History' a series of learned papers, the practical value of which has always been very seriously diminished by the absence of illustration. To a slight extent this omission was repaired by their 'Monograph on Recent and Fossil Crinoidea,' which appeared at intervals from 1843 to 1849 *. Other early workers in this fruitful field were W. A. Lewis and J. C. Pearce.

* The destruction of the original covers renders it difficult to settle the dates of the various parts with exactness; but a consideration of all the evidence has suggested the following table:—

Thus far work had chiefly been done on the Palæozoic Crinoids, and some of this is improved upon by F. M'Coy in his 'Description of the British Palæozoic Fossils in the Geological Museum of the University of Cambridge' (1851). But English workers in the latter half of the century have rather withdrawn their attention from these earlier forms, and the works to which chief reference must now be made are those by L. G. de Koninck, to whom many of our Carboniferous genera and species are due, and the 'Iconographia Crinoideorum in stratis Sueciæ siluricis fossilium' of N. P. Angelin (1878), the Crinoids proper edited by G. Lindström. In this latter work only one actually British specimen is described, *Periechocrinus interradiatus*, and that probably not a good species; but, as it is well known how close a connexion exists between the British and Scandinavian Silurian deposits, we may expect to find other of Angelin's species represented in this country. A visit to Sweden during the present year will I hope enable me to settle some of the questions that at present vex the minds of many English students. If, however, British workers have not of late done much on Palæozoic Crinoids, some good work stands to the credit of W. H. Baily, R. Etheridge, Jun., J. G. Grenfell, W. P. Sladen, and above all J. Rofe, whose well illustrated papers in the 'Geological Magazine' (1865, 1869, 1871, 1873) added much to our knowledge of the structure of Carboniferous forms. Many names of more or less value are due to the 'Catalogue of Fossils in the Woodwardian Museum,' by J. W. Salter (1873).

The year 1850 saw the Cretaceous Crinoids attacked by E. Forbes in F. Dixon's 'Geology of Sussex,' a piece of work by no means so good as his 'Monograph of the Echinodermata of the British Tertiaries' (1852). Some Liassic Crinoids have been described by F. M'Coy (1848) and T. Wright (1854) in the 'Annals and Magazine of Natural History,' and by Tate and Blake in 'The Yorkshire Lias' (1876). During the last ten years almost the only writer has been P. H. Carpenter, who has chiefly confined himself to the Comatulidæ.

No.	1.	Sig.	B, C.	Pp.	1–16.	Pls.	I., II.	1843.
„	2.	„	D, E.	„	17–32.	„	III., IV.	1844.
„	3.	„	F, G.	„	33–48.	„	V., VI.	1844.
„	4.	„	H, I.	„	49–64.	„	VII., VIII.	1845.
„	5.	„	J, K.	„	65–80.	„	IX., X.	1846.
„	6.	„	L, M.	„	81–96.	„	XI., XII.	1847.
„	7.	„	N, O.	„	97–112.	„	XIII., XIV.	1848.
„	8.	„	P, Q.	„	113–128.	„	XV., XVI.	1849.

Notwithstanding this roll of honourable names, a roll which might even be extended, it is possible for one of the chief living authorities on Palæozoic Crinoids—Dr. Charles Wachsmuth—to say in a letter dated Dec. 30, 1889, "The British Crinoids . . . . are in a greater confusion than the Crinoids of any other country." The causes for this state of things, which cannot but be considered a discredit to British Palæontology, are two. First, much of the work done by the older writers is worse than valueless (it is as well to speak the plain truth at once, however repugnant to one's feelings); drawings, when given, are often unlike the specimens; the descriptions incomplete, if not inaccurate. This is no mere expression of opinion, but a simple fact proved over and over again by the inability of eminent foreign workers to recognize many genera and most species. Much, however, may be pardoned to the pioneers of the science; their attempts were heroic, and their failures naturally splendid. The second cause is the lack of recent workers; not only have men been wanted to describe many new genera and species, but some one has been especially needed who should revise the work of his predecessors in accordance with the advanced state of knowledge. Had Sir Wyville Thomson lived this reproach would no doubt have been removed; and we may not blame those who were restrained by etiquette from trespassing on a field supposed to have been claimed by another.

Delay is no longer excusable. The chief fossiliferous localities all over the country have been well ransacked, and many are now no longer worked; a few more species may be found no doubt, but a vast mass of material in museums and in private collections awaits description. Further, by the publications of Messrs. Wachsmuth and Springer in America, and by those of Dr. P. H. Carpenter in this country, the task for both Palæozoic and Neozoic Crinoidea is rendered far more easy than it would have been ten years ago. This task then I propose to undertake in a series of papers: already I have received much encouragement, much kind help, and many promises of assistance; but I would here appeal to every one who owns or who is in charge of collections of British Fossil Crinoids to aid me with information or by the loan of specimens. Every specimen entrusted to me will be taken all possible care of, and returned to its owner or guardian at the earliest possible opportunity.

I should greatly prefer to deal with the Crinoids in an order determined solely by zoological affinity; but localities, collections, and considerations of expense will probably necessitate a more geological arrangement. I propose therefore to begin with the Dudley Crinoids, with which everyone is acquainted, but of which we have as yet no real knowledge. And I shall deal first with the section that appears to be most simple morphologically—the Inadunata Fistulata; what genera are herein contained will be seen from the ensuing paper.

I would also ask anyone who may be kind enough to lend me specimens to endeavour to give some definite information as to horizon and locality. The late President of the Geological Society lamented the lack of British palæontologists; but how can palæontology exist at all in a land where almost every Palæozoic fossil is labelled:—"Wenlock Limestone, Dudley," "Devonian, Devonshire," or "Carboniferous, Yorkshire"?

II. *The Classification of the Inadunata Fistulata.*

(Plate XIV.)

Common Characters.

Under the name "Fistulata" Messrs. Wachsmuth and Springer brought together in 1886 the following families as defined by them, viz., Hybocrinidæ, Heterocrinidæ, Anomalocrinidæ, Belemnocrinidæ, Cyathocrinidæ, Poteriocrinidæ, Encrinidæ, Astylocrinidæ, Catillocrinidæ, and Calceocrinidæ. In common with other Inadunata the genera referred to these families possess the following characters:—no interradials, and no plates above the radials proper, are included in the dorsal cup; there may, however, be from 1 to 3 plates (not homologous with interradials) in the posterior interradius; infrabasals may or may not be present; the plates of the cup are joined to one another by close suture. Among themselves the genera of the Fistulata agree in the following characters:—the food-grooves pass from the arms, along the surface of the tegmen, between the orals (when these are present) to the mouth, and are protected, on the disk as on the arms, by alternating covering-plates; in the anal or posterior interradius the perisome of the tegmen is extended ventrally as a sac often of large size.

The ventral sac of the Fistulata, from which the name of the group is derived, appears to differ from the anal tube of some Camerata no less than from the smaller anal opening of other Crinoids. Dr. Wachsmuth in 1877 wrote as follows:—"It evidently formed a large portion of the

* "Notes on the Internal and External Structure of Palæozoic Crinoids," Amer. Journ. xiv. 115–127, Newhaven, 1877, see pp. 126–127.

visceral cavity. Its great size compared with the lower cup, the presence of large numbers of small pores, and the position of the anal aperture near the bottom instead of at the summit, seems [*sic*] to imply that the anal apparatus occupied in the internal economy of this sac only a limited space. The inflated sac can accordingly not be homologized with the slender, heavy plated tube of *Actinocrinus.* We can only compare its lateral opening, which is generally placed low down near the arm-bases, with the anal aperture of species in which the anus is located in the ventral disc." In 1879 Messrs. Wachsmuth and Springer add * to this, that the plates are thin, that "the pores perforate the plate at each angle," that "in some species there are in place of the pores slit-like fissures of considerable length" which they compare with hydrospires of Cystidea, and that the anal opening is "rarely observed, evidently lateral—not posterior—and low down." To this view of the ventral sac they have since adhered (Rev. III. (83), Proc. 1885, p. 305). It is, however, difficult to distinguish any pores or slits in the common *Cyathocrinus* of our Wenlock Limestone, which appears to be identical with *C. acinotubus* of Angelin †, neither do Angelin's figures of *Cyathocrinus alutaceus*, *C. glaber*, *C. muticus*, and *C. ramosus* show any trace of pores. Further, I have been unable to find any anal opening in the best preserved specimens of *Gissocrinus* in the British Museum, which are the only specimens displaying its supposed position that have come under my notice. I am not aware that the anal opening of any Fistulate has as yet been figured or even definitely described. It is possible that the anal opening is at the distal extremity of the sac after all, but that its minuteness, and the closing of the plates around it after death have prevented its recognition. Even with recent Crinoids, as Dr. P. H. Carpenter tells me, a similar difficulty is often experienced. But these slight objections, supposing them to prove well founded, would hardly disturb the main contention of Messrs. Wachsmuth and Springer, that the ventral sac of the Fistulata is a peculiar organ unparalleled in other groups. Besides promoting excretion it probably sub-

* "Revision of the Palæocrinoidea, Part I." (pp. 9 and 60), Proc. Ac. Nat. Sci. Philadelphia, 1879, pp. 232 and 283. In future this work will be referred to as "W. & S. Revision,' and the pages of the authors' copies given in brackets; the reference to the Proceedings will be indicated thus, "Proc. 1879, p. 232."

† H. Trautschold places the ventral sac of *C. acinotubus* with that of the ordinary *Actinocrinus* type ("Ueber den muthmasslichen Geschlechtsapparat von *Poteriocrinus multiplex*, Trd.," Festschrift k. Gesell. Naturforscher, Moscow, 1882).

served respiration; but whether, as Trautschold has suggested *, it was also connected with reproduction seems more than doubtful. Further, in its morphological relations to the plates of the dorsal cup it differs, as will shortly be seen, from the anal tube of other Crinoids.

The Fistulata then are justly separated as an easily recognized group. But it is one that has presented many difficulties to the systematist, as evidenced by the numerous and conflicting classifications that have been proposed. Into all these it is as unnecessary, as it would be wearisome, to enter; for the observations and erudition of Messrs. Wachsmuth and Springer enabled them, four years ago, to put forward a classification which was an enormous advance on all systems previously maintained either by themselves or by other authors. Since that time one or two alterations, occasionally for the better, have been proposed; and these will be alluded to in their proper place. Mr. S. A. Miller, in his recently published 'North American Geology and Palæontology' (Cincinnati, 1889), has on pp. 214–216 given a classification of Palæozoic Echinodermata, to which politeness necessitates some allusion. It is, however, so remarkable a production that only the previous work done by this enthusiastic palæontologist can induce one to believe that he has put it forward in good faith. It is then the genera as defined by Messrs. Wachsmuth and Springer, to which one or two may be added, and the families into which those genera were by them distributed, that will form a natural basis for the following discussion.

Discussion indeed might seem unnecessary, especially as the new forms to be hereinafter described do not throw much fresh light on the subject. But, in endeavouring to assign these new forms to their place in the system, I was confronted by certain difficulties. Thinking that those difficulties were due to my own obtuseness or ignorance, I attacked the subject afresh on every side. Still, now that all is done, I find myself unable to accept in their entirety the views of Messrs. Wachsmuth and Springer; and, thinking it hardly compatible with scientific honesty to describe forms in terms with which I cannot agree, I feel bound to set before the public what seems to me to be the truth of the matter.

Terminology.

Before plunging into a lengthy argument it will be as well to clear the ground by an explanation of the terms employed.

* *Op. cit.*, and "Ueber Crinoideen, Zusätze und Berichtigungen," Bull. Soc. Imp. Nat. Moscou, lvii. pp. 140–145 (1882).

Nothing conduces so much to the advancement of science as a uniformity of terminology, especially if such terminology be based on scientific principles. That of the Crinoidea is only just assuming shape and fixity, and that it does so at all is due chiefly to the labours of Dr. P. H. Carpenter. To him I am indebted for some notes explaining the terms which will in future be used by himself and by Messrs. Wachsmuth and Springer: these notes are quoted as P. H. C. (MS.). To these terms I shall adhere so far as my judgment will permit me. I shall also adopt the terms proposed by the same authorities in Wachsmuth and Springer's paper "Discovery of the Ventral Structure of *Taxocrinus* &c." (Proc. Acad. Nat. Sci. Philadelphia, 1888, p. 354, footnote 3), with one exception: these terms are quoted as W. & S. & C.

Crown=Crinoid minus the stem.—W. & S. & C.

Calyx=Crinoid skeleton minus stem and free arms.—W. & S. & C.

Dorsal cup=all parts of the calyx below the origin of the free arms.—W. & S. & C. I should myself have preferred to retain "calyx" for the dorsal cup, and to have used some such word as "cyst" in its place; "calice" is the natural French word for "cup," and the alternative "la tasse dorsale" smacks a trifle too much of the tea-table. Proposers of technical terms should remember two things: to avoid words already overweighted with meanings; and to use words that can be easily transferred to other tongues: hence the advantage of Latin or Greek over the vernacular. But in this instance I content myself with a protest.

Tegmen=that part of the calyx lying above the origin of the free arms. This one term includes both "disk" and "vault" of W. & S. & C., since I do not believe in the existence of a structure "covering the disk." This cannot be argued out here, and will be better discussed when treating of the Camerata. The term "tegmen calycis" was used in the same sense by Zittel ('Palæontologie,' 1879).

Infrabasals=the radially situated circlet of plates proximal to the stem; not always present. This term is preferable to "Under-basals," which Dr. Carpenter always uses, because the latter word is a mongrel, half Latin half English, and cannot be used in any language as "Infrabasal" can.

Basals=the interradially situated circlet of plates either proximal to the stem or ventrad of the Infrabasals when those are present. The "parabasals" of some authors.

Radials=the radially situated circlet of plates ventrad of the Basals, and this circlet only.—P. H. C. (MS.).

Brachials. "In forms with 5 undivided arms (e. g. *Symbathocrinus*) the Radials bear the Brachials directly; and throughout the whole group every joint beyond the Radial is morphologically a Brachial, as is shown both by comparative anatomy and by embryology."—P. H. C. (MS.).

Costals=Brachials of the first order; the second and subsequent primary radials of W. & S. are now called 1st, 2nd, &c. costals, up to the axillary. "Miller used this term in *Apiocrinus*, *Pentacrinus*, and *Comatula*."—P. H. C. (MS.).

Distichals=Brachials of the second order; used by Miller.—P. H. C, (MS.).

Palmars = Brachials of the third order.—P. H. C. (MS.).
Postpalmars = Brachials of the fourth order.
Free brachials = "the component pieces of the arms beyond the last axillary."—P. H. C. (MS.).
Syzygy. "Only used for the immovable (?) union between two brachials, in which the hypozygal loses its pinnule (supposing pinnules to occur). The apposed faces may be smooth (some *Pentacrini*), striated (most *Comatulæ*), or dotted (some *Actinometræ*)."—P. H. C. (MS.).
Close Suture. "The apposed surfaces smooth or partially striated. *Ex.* All the subradial plates, both laterally and longitudinally; the calyx-plates of most Camerata, some Platycrinidæ excepted."—P. H. C. (MS.).
Loose Suture. "Distinguished by the formation of a more or less developed facet, cut out of the edge of the plate. It may be smooth, striated, or have faint ridges, and is sometimes perforate. *Ex.* The union between radials and costals of some Platycrinidæ. The brachials of the Camerata, Cyathocrinidæ, and some Poteriocrinidæ. The radials and interradials of the Articulata. Stem-ossicles. Pinnule-ossicles of many Neocrinoids."—P. H. C. (MS.).
Muscular Articulation. "The articular ridge, whether vertical or transverse, is always perforate. *Ex.* The brachials in all Articulata, and in some Poteriocrinidæ and Encrinidæ (uniserial arms only)."—P. H. C. (MS.).

Instead of the terms here given, Dr. Carpenter proposes to use "Synarthrosis" for Close Suture, "Amphiarthrosis" for Loose Suture, and "Diarthrosis" for Muscular Articulation. But it is very doubtful whether the adoption of terms from Vertebrate anatomy is wise, especially when, as in this case, the terms connote certain relations of bone, cartilage, and synovial membrane, tissues that do not exist in the Crinoidea. I shall therefore use the equivalents with which Dr. Carpenter has fortunately favoured me.

As any other of the old terms used by me will be used in the accepted sense it is unnecessary here to explain them; any new terms that may seem necessary will be defined as they are introduced. It is, however, important to explain the orientation adopted. Any attempt at a purely morphological orientation is impossible so long as homologies with other Echinodermata remain uncertain. For practical purposes it is best to consider the adult Crinoid in its natural position, *i. e.* with the ventral disk uppermost, and then to view it from the anal side. The anal interradius will then be Posterior, the radius opposite to it will be Anterior, Left and Right will correspond with the left and right of the observer. Viewed from above, with the anterior radius away from the observer, Right and Left remain the same. To preserve this orientation when the dorsal cup is viewed from below, the anterior radius must be nearest to the observer. The accompanying Table compares this with the various systems of nomenclature that are in use; I give Lovén's 'without prejudice,' not implying any homology between Echinozoa and Pelmatozoa. In his 'Challenger' Reports Dr. Carpenter has spoken of B and C as Right, D and E as Left; but he agrees with me that the orientation adopted by Wachsmuth and Springer, which is the one I now follow, is practically the most convenient for the description of fossil Crinoids.

P. H. C.'s Alphabetical Nomenclature, following course of Gut.	Orientation here followed.	Lovén's Nomenclature for Echinozoa.	Geographical Method of describing Ventral Surface.
A	Anterior Radius.	III.	N.
A–B	Right Anterior Interradius.	3.	N.N.E.
B	" " Radius.	IV.	N.E.
B–C	" Posterior Interradius.	4.	E.
C	" " Radius.	V.	S.E.
C–D	Posterior Interradius.	5.	S.
D	Left Posterior Radius.	I.	S.W.
D–E	" " Interradius.	1.	W.
E	Right Anterior Radius.	II.	N.W.
E–A	" " Interradius.	2.	N.N.W.

In using the terms *Proximal* and *Distal* I reckon from the Chambered Organ; so that the Infrabasals and the top Stem-ossicle are the proximal elements of Crown and Stem respectively.

Differential Characters.

Of the many characters in which the genera of the Fistulata differ from one another, the following have been with justice considered as of chief importance :—

A. The Base: whether Dicyclic or Monocyclic; if the former, whether the Infrabasals are 5 or 3 in number.

B. The Anal Area of the Dorsal Cup: the number of plates, from 0 to 3 or possibly more, that are included; the relations of those plates to one another and to the adjoining plates.

C. The Arms: whether simple, dichotomously branching, or with lateral armlets; whether pinnules are present or absent.

D. The Mode of Union between Plates and Ossicles: whether Syzygy, Close Suture, Loose Suture, or Muscular Articulation prevails.

In attempting to construct a natural classification care must be taken not to fix on any one character to the exclusion of others; since, however, it would be impracticable to discuss all the above points at once I shall proceed to deal with them in the order just indicated.

A. *The Base.*

Our views as to the difference between Monocyclic and Dicyclic forms have of late undergone considerable change, chiefly owing to the discovery of minute infrabasals in either the embryonic stages or the adult of many forms previously supposed to be without them *. At the same time these discoveries have confirmed the rule laid down by Wachsmuth and Springer:—that where infrabasals are present the angles of the column are interradial and the sides of the column, the lobes of the axial canal, and the cirri are radial; but that where infrabasals are absent these conditions are reversed †. While therefore many forms turn out to be Pseudo-Monocyclica, the distinction between true Monocyclica and Dicyclica is if anything strengthened.

To turn to the Fistulata. In the Hybocrinidæ no infrabasals have been observed; but Wachsmuth and Springer suggest (Rev. I. (74) Proc. 1879, p. 297) that those plates are "probably rudimentary," and, as the simplicity of the column precludes definite proof, we may have to consider the

* See especially H. Bury, "The Early Stages in the Development of *Antedon rosacea*," Phil Trans. clxxix. B (1888), pp. 257–301, London, 1889. Infrabasals on pp. 270–271, 288–289, pl. xlvi. fig. 46, pl. xlvii. figs. 48, 52, 53.

† See this rule more fully stated in their paper "Discovery of the Ventral Structure of *Taxocrinus* &c.," Proc. Ac. Nat. Sci. Philadelphia, 1888, p. 351.

family as pseudomonocyclic. The Heterocrinidæ, Anomalocrinidæ, and Belemnocrinidæ are all truly monocyclic; while the remaining Fistulata are undoubtedly dicyclic. Is this fact alone enough to warrant a separation into two groups?

This question involves two others. First; can one group be derived from the other? Second; if so, which group is ancestral? Let me repeat that this is not a question of the origin of Pseudomonocyclica, for they, it is obvious, are derived from Dicyclica; but it is a question of the relations between Dicyclica and Monocyclica Vera.

It has hitherto been generally supposed that the Monocyclic stage is the older of the two. No particular reasons have been given for this opinion beyond the natural one that a dorsal cup formed of two circlets only is simpler than one formed of three. Such an argument however, unless supported by Palæontology or Embryology, really begs the question; the hoof of *Equus caballus* is from one point of view simpler than the 5-toed foot of *Phenacodus*, but it is not simpler when origins are considered. Those who take the Monocyclic type to be the older may suppose that infrabasals were subsequently developed as a new and sudden accession to the elements of the dorsal cup. This idea again has the merit of simplicity, but it overlooks the difficulty of a change in the orientation of the stem. It is true that in the species of *Antedon* described by Mr. Bury the infrabasals appear after the basals; but *Antedon* is so specialized a form, and the infrabasals are in so extremely degenerate a state, that no morphologist could attach any importance to this fact. Should the monocyclic base of the Inadunata Larviformia, which Wachsmuth and Springer regard as more ancestral than the Fistulata, be adduced in favour of this view, it would be enough to point out that, with the exception of the very irregular *Pisocrinus* (Wenlock and Niagara), they have not been found below the Devonian. Dr. J. Walther *, who likewise derives Dicyclica from Monocyclica, is forced by difficulties of orientation to homologize Monocyclic basals with Dicyclic infrabasals, and Monocyclic radials with Dicyclic basals, while he regards the radials of Dicyclica as an entirely new element in the dorsal cup. This view implies that the arms, the anus, and the elements of the tegmen have turned through an angle of 36°: a comparison of *Iocrinus* and *Merocrinus* (Plate XIV. figs. 5 & 11) shows the extreme difficulty of accepting such a reversal of our accepted homologies. It is just to Dr. Walther to remember that his very suggestive

* "Untersuchungen über den Bau der Crinoiden u.s.w.," Palæontographica, xxxii. pp. 155–200. Stuttgart, 1886.

paper was published before Mr. Bury's researches on *Antedon*; had he been acquainted with these, and also better acquainted with the earlier Palæozoic crinoids, he would hardly have written as he did.

On the other hand, the tendency of infrabasals to diminish in size during geological time, in other words the general change of Dicyclica into Pseudomonocyclica, suggests that the Dicyclic type is more primitive than the Monocyclic. In this connexion we may recall Wachsmuth's statement that basals and infrabasals seem to be early developed in the individual, "for they are as large in the young as in the adult, and do not show much increase in proportions in later geological epochs" (Rev. I. (19), Proc. 1879, p. 242). One might also allude to the stems of some Bohemian Cystidea, which are composed of alternating circlets of plates as though developed in extensions of the calycal perisome. The only objection to the derivation of Monocyclica, through Pseudomonocyclic stages, from Dicyclica, lies in the involved change of orientation. Here, however, it seems to present less difficulty than on the converse hypothesis. The atrophy of infrabasals is we see a very gradual process, and, as proved by specimens of *Forbesiocrinus* in the British Museum, it does actually appear to be in some cases accompanied by a change in the position of the lobes of the axial canal.

So far as the Fistulata are concerned there is no geological evidence to show whether Monocyclica, Pseudomonocyclica, or Dicyclica be the older. All my contention is that Monocyclic forms may, should other evidence render it probable, be derived from Dicyclic.

The distinction between an infrabasal ring of 5 plates and one of 3, is of far inferior importance. It is acknowledged that 3 infrabasals represent the original 5, of which two pair have fused and the 5th remains as a rule in its pristine condition. In the Fistulata, as in *Antedon*, this unaltered infrabasal is that in the anterior radius; the fused pairs are therefore those of the left and right sides respectively. This fusion of infrabasals may be regarded as a generic character, but nothing more; for any genus with 5 infrabasals may have its analogue with 3 infrabasals, as, for example, *Cyathocrinus* has *Gissocrinus*. It is fairly obvious that an infrabasal ring of 5 plates is more ancestral than one of 3, and that one small and two large infrabasals represent a more archaic stage than do three equal infrabasals. In *Stemmatocrinus* the infrabasals are anchylosed into a pentagonal disk, and this is no doubt a later development. No cases of 4 or 2 infrabasals are known in the Fistulata.

B. *The Anal Plates.*

We have now to consider the character that forms the basis of Wachsmuth and Springer's classification, viz., the number and relations of the plates in the posterior interradius. And first it may be pointed out that, as interradials do not enter into the composition of the dorsal cup in any Fistulate, none of these plates can well be the homologues of interradials: in many of the Camerata actual interradials are present in the anal area, but in the Fistulata at least we must look elsewhere for the origin of the so-called "anal" plates.

Physiologically these plates have a two-fold importance. Their chief function is to actually support the ventral sac: in *Catillocrinus* (Pl. XIV. fig. 29), for example, the "anal plate" is on a level with the arm-joints and supports a single row of large and heavy plates; in *Iocrinus* (Pl. XIV. fig. 5) the "anal plate" merely serves to support a line of stout plates which form a median ridge to the ventral sac. Their second function is to increase the space between the right and left posterior radials, so as to allow room for the free development of the sac: of this *Euspirocrinus* (Pl. XIV. fig. 17) and *Poteriocrinus* (Pl. XIV. fig. 26) are good examples. This physiological aspect of the question is noteworthy, because it assists our comprehension of the morphological relations of the plates.

The main types of structure are familiar to all students of Palæozoic Crinoids; but for convenience of reference I have given diagrams of the composition of the dorsal cup in every genus of the Fistulata (Pl. XIV.). These diagrams, which are compiled from the best authorities and verified when possible by reference to actual specimens, will also serve to draw attention from the confused masses of verbiage that have somewhat obscured the subject, and to concentrate it on the facts themselves. To further dispel prejudice, the plates as to which any doubt exists are, in the main diagrams, left unlettered; but they are repeated alongside with the various interpretations that have been or that may be placed upon them. The more important variations are those presented by *Hoplocrinus* (1 & 2), *Hybocrinus* (3), *Baerocrinus* (4), *Iocrinus* (5), *Heterocrinus* (6), *Dendrocrinus* (15), *Homocrinus* (16), *Cyathocrinus* (20), *Poteriocrinus* (26), *Botryocrinus* (30), and *Ceriocrinus* (38); and I would request any not already well acquainted with the structure of those genera to study the diagrams of them before proceeding.

Fluctuations of opinion have rendered this subject so perplexing that it will be well to give a short historical sketch of the views of the leading authorities.

In 1879 Messrs. Wachsmuth and Springer (Rev. I. (71–72) and footnote, Proc. pp. 294, 295) noting that Hall had wrongly described the ventral sac of *Iocrinus polyxo* as an arm, wrote: "the similarity in the appearance of the ventral sac and the arms and pinnulæ is indeed most striking. If there is in nature any such thing as a transmutation of one organ into another, it would seem that such was the case here, and this may lead to a better understanding of the functions of the ventral sac"; and again (Rev. I. (65), Proc. 1879, p. 288) "was not the ventral tube here [in *Iocrinus*], and in Crinoids generally, originally a modified arm? This, if true, would at once explain why the anal area leans always towards the right and never to the left side of the body." *Iocrinus* (Pl. XIV. fig. 5) then was taken by them as the starting-point: the axillary plate that supports on the left the ventral sac and on the right an arm, was regarded as a costal with inter-radial functions, and the plate on which it rests as a radial homologous with the other radials of the dorsal cup. In *Dendrocrinus* (Pl. XIV. fig. 15) the right posterior radial was supposed to have split transversely into two plates (R and R+), both "strictly radial" and "homologous with the single radial in other Cyathocrinidæ." The plate (×) that in *Iocrinus* was supported by a costal, has here passed down into the dorsal cup and is "a regular anal plate." In *Homocrinus* (Pl. XIV. fig 16) "the suture between the sections of the compound plate (R and R+) is sloping instead of horizontal" and "by this trifling alteration" R+ is "transformed into an anal plate." "This was the first step towards a *Poteriocrinus* anal arrangement, and in fact to complete it required only the interposition of a third small plate," *i. e.* a plate (*t*) of the ventral tube, to come down between × and R (Pl. XIV. fig. 26). *Cyathocrinus* (Pl. XIV. fig. 20) arose from *Dendrocrinus* by "the consolidation of the compound plate into one," *i. e.* R+ is rejoined to R, but occasionally remains as in *Botryocrinus* and *Barycrinus* (Pl. XIV. fig. 30). Similarly in *Heterocrinus* (Pl. XIV. fig. 6), which then included *Ectenocrinus* (Pl. XIV. fig. 7), Wachsmuth and Springer regarded R+ as the lower part of a compound radial; the two plates that occur in the right posterior and right and left anterior radii were considered homologous with a complete single radial. So far, whether correct or not, they were consistent: but in *Hybocrinus* (Pl. XIV. fig. 3) they regarded the large plate, which exactly corresponds in position to R+ of *Homocrinus*, as an anal plate pure and simple homologous with ×. They admitted indeed that the small right posterior radial only equalled the upper half of the radial (R) of *Dendrocrinus*, but the lower half (R+) appeared to them to be absent, "though perhaps represented in a portion of the large undivided anal plate." This view again may or may not have been correct, but it was hardly consistent with their explanation of the other forms. Nothing was said about the homologies of the anal plates in *Hoplocrinus* and *Baerocrinus*, with which genera Wachsmuth and Springer were then unacquainted.

In 1882, Dr. P. H. Carpenter published an important paper "On the relation of *Hybocrinus*, *Baerocrinus*, and *Hybocystites*." [Quart. Journ. Geol. Soc. no. 151, vol. xxxviii. pp. 298–312, pl. xi. London, Aug. 1882.] Under the name *Hybocrinus*, Carpenter then included the American genus *Hybocrinus* of Billings and the European *Hoplocrinus* of Grewingk; I here follow Wachsmuth and Springer in maintaining the distinctness of the two genera. In this paper while "concurring in the views of Messrs. Wachsmuth and Springer respecting the mutual relations of *Hybocrinus*, *Homocrinus*, and *Dendrocrinus*," Dr. Carpenter is "not altogether in accordance with them as to the relations of these three types to *Iocrinus*." He "cannot follow their comparison of" the dorsal cup of *Iocrinus* "with *Dendrocrinus*." This indeed is obvious, for he misquotes their comparison, and states that Wachsmuth and Springer homologize the lower half of the compound radial in *Dendrocrinus* (Pl. XIV. fig. 15, R+) with the upper axillary plate in *Iocrinus* (Pl. XIV. fig. 5, C). The learned Americans are not, it is true, always easy to understand, but it is hardly fair to suppose that they talk nonsense. This incomprehensible fiction, however, appears to be the reason why Dr. Carpenter "cannot follow these authors in regarding *Iocrinus* as the starting-point from which the development of the anal plates may be traced from one genus of the Cyathocrinidæ [=Fistulata] to another." "Viewed in a purely embryological aspect, *Cyathocrinus* or a Dendrocrinoid form with the two halves of the 'compound radial' [R and R+] united, is a lower type than *Iocrinus*. For the continuous line of the radials is broken into by the anal plate [×], which is in direct contact with a basal, as in the early Pentacrinoid." This argument assumes, rightly or wrongly, that the anal plate × is homologous with the anal of the *Antedon*-larva. Further, Dr. Carpenter sees the inconsistency of Wachsmuth and Springer's attitude towards *Hybocrinus*, and prefers to homologize the whole of the large "anal" plate in that genus with the lower part of the compound radial of *Dendrocrinus*: he regards it "as a modified radial, the arm-bearing portion of which has been cut off," and he names it the "azygos" plate. In *Hoplocrinus* too he thinks that "the azygos plate is fundamentally a modified radial belonging to the right posterior ray," though here "that the anal [×] and azygos [R+] plates may have fused is possible enough."

In 1883 Messrs. Wachsmuth and Springer continued the discussion in a paper "on Hybocrinus, Hoplocrinus, and Baerocrinus" (Amer. Journ. xxvi. 365–377, Newhaven, Nov. 1883), where they laid the foundation of their present views. In this paper they accepted P. H. Carpenter's homology of the large "anal" plate of *Hybocrinus* with the lower half of the radial in *Dendrocrinus* (R+), and they adopted for it his term "azygos." At the same time, whether in consequence of Carpenter's criticism or not, they executed a complete *volte-face* on the subject of *Iocrinus*. They curiously misquote Carpenter as having suggested that the axillary plate of *Iocrinus* was an "azygos" plate, whereas he distinctly admitted it to be a "brachial," *i. e.* costal. Instead they "insist that it is the equivalent of the combined small radial [R] and small anal plate [×] in *Hybocrinus*, and that the large plate underneath, which both Carpenter and [Wachsmuth and Springer] took to be a radial, is an azygos plate." They now take *Baerocrinus* (Pl. XIV. fig. 4) as starting-point, and regard it as having only four radials and "a large undivided azygous plate of similar form." This plate Carpenter had regarded as a radial; but Wachsmuth and Springer consider that the plate which in other genera represents the right posterior radial is not here developed. In *Hoplocrinus* the right posterior radial is again developed (Pl. XIV. fig. 2); it gradually absorbs the right upper corner of the "azygos" plate (Pl. XIV. fig. 1), until, in *Hybocrinus*, it attains somewhat more the shape of an ordinary radial (Pl. XIV. fig. 3). In *Hybocrinus* "the upper left corner of the azygous plate has become divided off into a special anal plate." *Iocrinus* (fig. 5), *Dendrocrinus* (fig. 15), *Homocrinus* (fig. 16), and *Botryocrinus* (fig. 30) are regarded as a series in which "the posterior radial grows larger by absorbing more and more the azygous plate," until in *Cyathocrinus* (fig. 20) it has disappeared. In this paper then the authors consider the "azygos" plate to be an independent morphological element of the dorsal cup, *not* a modified radial; *e. g.* the two plates in the right posterior radius of *Dendrocrinus* do *not* represent a compound radial: and they have given up the idea that the ventral sac is developed from an arm. As to the homologies with *Antedon*-larva, they differ from P. H. Carpenter, for they write: "The different phases in the Paleontological development of the azygous side . . . . . resemble most remarkably the stages of growth in the anal arrangement of *Antedon* . . . . At a time when even the radials were yet imperfectly developed, we find in both forms a large anal (azygous) plate (*Baerocrinus*), which is lifted out from between the radials (*Hybocrinus*) and becomes developed into a conspicuous funnel (the later Cyathocrinidæ), until at the termination of Pentacrinoid life and the close of the Carboniferous, the anal plate disappears entirely [*Erisocrinus* (39)]." ". . . The 'anal' plate of the young *Antedon* is not the homologue of the . . . . . . 'special' anal plate [×], but . . . . . . of the undivided azygous plate in *Baerocrinus* and *Hoplocrinus* [Az] . . . . . The special anal plate in *Hybocrinus* is the first step towards a plated tube."

In 1885 Messrs. Wachsmuth and Springer [Rev. III. Section 1 (11, 12, & 40), Proc. 1885, pp. 233, 234 & 262] substantially repeat their 1883 hypothesis, with, however, the following important additions and alterations. The lower segments of the compound radials, where such occur, were probably embryonal plates (*i. e.* of an ancestral character), which were absorbed by the upper segments or permanent radials in the same way as the "azygos" and "anal" plates were absorbed by the right posterior radial. The "azygos" piece may indeed itself represent one of these lower segments, viz., that of the right posterior radial; this is well seen in *Anomalocrinus* (Pl. XIV. fig. 8) and *Ectenocrinus* (Pl. XIV. fig. 7). This very slight admission does not really alter their previous view that the azygos plate was a primitive fundamental element of the dorsal cup; for what they give with the one hand they take away with the other, in that they make *all* the lower radial segments similar primitive elements. The anal plate (×) and the right posterior radial are as before supposed to be derived from the azygos. But they change their ideas as to the "anal" of *Antedon*-larva. The azygos plate, they now say, is unrepresented in the Pentacrinoid; this is odd, but perhaps it has been overlooked.

In 1886 Messrs. Wachsmuth and Springer re-enforce these views. [Rev. III. Section 2 (196 & 199), Proc. 1886, pp. 120 & 123.] The "anal" of *Antedon*-larva is an interradial with special function, while the azygos plate is as much radial as interradial. "They both agree, however, in being absorbed by other plates; the azygous plate palæontologically by the right posterior radial and anal plate, the other in the growing animal over the whole surface." Their remarks of three years back on *Hybocrinus* are now modified; and they show that this genus possessed a true ventral sac, though a very minute one. This organ is also present in *Hybocystis*. It is therefore probable that it was also present in *Hoplocrinus* and *Baerocrinus*, though not preserved in the few specimens known; Wachsmuth and Springer do indeed deny its presence, but, as they do not appear to have seen the specimens, their mere negative statement is no more than an opinion. It is unnecessary to give a further analysis of Wachsmuth and Springer's views as they at present stand, for they can be easily gathered from the diagrams. The most debatable points only have been alluded to, and on these we may summarize their position as follows:—

(1) Azygos plate (Az) a primitive element of dorsal cup.

(2) Anal (×) and right posterior radial derived from azygos plate.

(3) Anal of *Antedon* not homologous with any plate of the Fistulata but an embryonic interradial.

(4) Stages of evolution are:—

(a) *Baerocrinus*, 4 Radials and 1 Azygos (fig. 4).
(b) *Hoplocrinus*, large Azygos and small right posterior Radial (figs. 1 & 2).
(c) *Hybocrinus*, large Azygos, right posterior Radial increasing, and × developed (fig. 3).
(d) *Iocrinus*, Radial growing larger at expense of Azygos, and here has absorbed × (fig. 5).
(e) *Heterocrinus* and *Ectenocrinus*, Azygos diminishing, × here removed from it (figs. 6 & 7).
(f) *Dendrocrinus*, Radial still larger, Azygos smaller and touching × (fig. 15).
(g) *Homocrinus*, Radial larger, Azygos smaller, × larger (fig. 16).

Here is a dichotomy; one branch continues:—

(h) *Botryocrinus*, Radial nearly normal, Azygos small, × large (fig. 30).
(i) *Cyathocrinus*, Radial normal, Azygos entirely absorbed by Radial, × very large (fig. 20).
(j) *Achradocrinus*, the same, but × becoming absorbed (fig. 22).
(k) *Codiacrinus*, Radial normal, Azygos and × entirely absorbed (fig. 23).

The other branch continues :—

(l) *Poteriocrinus*, Radial nearly normal, Azygos and × of about equal size, a plate of the tube, *t*, sunk into dorsal cup (fig. 26).

(m) *Zeacrinus*, Azygos beginning to merge in Radial, × smaller and *t* not so low down (fig. 27).

(n) *Ceriocrinus*, Azygos and × both absorbed, *t* alone remains partly in dorsal cup (fig. 38).

(o) *Erisocrinus*, Azygos and × absorbed, *t* again risen above limits of dorsal cup (fig. 39).

The later stages from the *Homocrinus* type downwards, in either branch, will no doubt be generally accepted; only in a few of the details one might prefer a different interpretation. But as regards the earlier stages and on points 1, 2, and 3, I have to differ entirely. In fact I would almost assume the position originally occupied by Messrs. Wachsmuth and Springer, which, it seems to me, they abandoned for quite insufficient reasons. But before bringing forward any new ideas, it will be better to attack those which at present hold the field.

The history of this controversy is curiously full of misunderstandings and misrepresentations. I hope that I have made no such mistakes: I have done my best to avoid them; and Dr. Carpenter, who has kindly looked through the MS. of the present paper, agrees to my account both of his own paper and, so far as he can judge, of the papers by Messrs. Wachsmuth and Springer. In the first place Wachsmuth and Springer turned to the right about in 1883 without giving any reason, and the only discoverable reason is the criticism by P. H. Carpenter. But of this criticism half, as already pointed out, was based on a complete misapprehension of Wachsmuth and Springer's views, while the other half was based on a homology of the *Antedon* anal that is denied by Wachsmuth and Springer. The latter authors have therefore still to give some reason for their desertion of a hypothesis that was in its main lines perfectly consistent.

But, taking things as we find them, let us proceed to consider the arguments based on the *Antedon*-larva. And first, what is the "anal" of the Pentacrinoid? It is not an interradial; for the so-called "interradials" that some observers claim to have seen are only perisomic plates of no morphological importance; further, it is a most gratuitous assumption to make *Antedon* the only form with an interradial in the anal area while devoid of true interradials in the other interradii. The supposition that the azygos plate exists in

Antedon, but as yet undiscovered, is rendered more untenable than ever by the fact that the elaborate researches of Mr. H. Bury (*loc. cit.*), as well as Barrois, Götte, and other previous workers, have failed to indicate any traces of it. At the same time the "anal" of *Antedon* is not the Azygos plate; for not only does it originate on a level with the radials, but it attains before its disappearance a far higher position than is attained by the Azygos plate in any fossil form. The idea of Messrs. Wachsmuth and Springer, that this plate is absorbed by the other plates, is quite unfounded; what Dr. W. B. Carpenter * wrote was:—"The entire plate is removed at once by a continuance of absorption over its whole surface," not "over *the* whole surface." The only adequate answer to the question is that given by P. H. Carpenter, viz., that the "anal" of the Pentacrinoid is homologous with the anal × in the adult Palæozoic Fistulata. The positions which it successively assumes can, as we shall see, only be explained on this hypothesis. To this answer I only see one objection; namely, that *Antedon* and the Fistulata have always been placed by both Wachsmuth and Springer and P. H. Carpenter in different "independent primary divisions" of the Crinoidea, and still are so placed †. But with this objection I must leave Dr. Carpenter himself to deal.

Secondly, whether this homology be granted or not, what light, on the assumption that ontogeny reproduces phylogeny, can a recent *Antedon* possibly throw on the ancestral conditions of Silurian Fistulata? Let us overlook the objection just mentioned, and let us suppose that *Antedon* is, after all, lineally descended from the Fistulata through either *Agassizocrinus* or the later Poteriocrinidæ—even then what does it tell us? It merely passes through the stages that are represented in the palæontological (*i. e.* the phylogenetic) series by *Ceriocrinus*, *Erisocrinus*, and *Stemmatocrinus*. In fact it hardly takes us back to the middle of the Carboniferous, certainly not to the Ordovician and Silurian genera. Consequently Dr. Carpenter's conclusion that "*Cyathocrinus*, or a Dendrocrinoid form with the two halves of the compound radial united, is a lower type than *Iocrinus*" falls to the ground. Under any circumstances his argument would prove *Ceriocrinus* and *Graphiocrinus* earlier than *Zeocrinus* or even *Heterocrinus*—a sufficient *reductio ad absurdum*.

* "Researches on the structure &c. of *Antedon* &c." Phil. Trans. vol. clvi. p. 747, London, 1866.

† P. H. C. in Nicholson and Lydekker's 'Manual of Palæontology,' i. p. 445, 1890.

The first point of Messrs. Wachsmuth and Springer, that the Azygos plate is a primitive element of the dorsal cup, rests on two assumptions. First, that *Baerocrinus* has only four radials and that the fifth plate is the azygos plate. In any case *Baerocrinus* is an abnormal form, but I fail to see that it becomes any more normal by this explanation. As there are two plates in the dorsal cup, neither arm-bearing, but each like the other and both in all other respects like the three radials, there is no conceivable reason why one should be called a Radial and the other an Azygos plate; except indeed the reason that Messrs. Wachsmuth and Springer's hypothesis would not otherwise hold water. The second assumption is that the lower halves of certain radials are embryonic plates. The dorsal cup of the early Pelmatozoa may no doubt have contained more plates than the fixed number of the Fistulata: but these plates, if any of them remained, would, as in *Acrocrinus*, alternate with the rest, and would probably be below the basals. On the other hand the compound radials of *Heterocrinus* and similar forms simply resemble an ordinary radial horizontally bisected, and as such they have been regarded by all other authors. Possibly the object of this structure was to give greater flexibility to a cup in which the more movable forms of joint were as yet undeveloped. At any rate, since the azygos plate is admitted to be the homologue of these lower segments of the radials there can be no adequate reason for regarding it as a primitive element of the dorsal cup.

Let us now consider the second point, viz., the derivation of the anal × and right posterior radial from the azygos plate Az. In the first place I fail to understand what Messrs. Wachsmuth and Springer mean by one plate absorbing another. A plate may be absorbed by the general tissues of the body in the individual, or it may be developed to a less extent in a line of descendants; at the same time other plates may increase in size and may ultimately occupy the room of the former: but to say that these plates absorb the other is either an incorrect or an unscientific statement. The derivation of the right posterior radial from Az cannot therefore be by any process of absorption; although it might, as P. H. Carpenter has suggested, make its first appearance as a small arm-bearing portion cut off from Az. But why should this be the origin of the right posterior radial alone? Why should not the upper radials of *Heterocrinus*, *Ectenocrinus*, and *Anomalocrinus* be similarly derived from the lower radials? This then is not only an assumption, but an inconsistent one. Similarly the derivation of × from Az is an assumption, and one that does not harmonize with the facts; for the two plates are widely separated in such early forms as *Ectenocrinus*, *Anomalocrinus*, and probably in *Heterocrinus*, *Iocrinus*, and *Merocrinus*. It may indeed have been this obvious objection that made Wachsmuth and Springer maintain that the axillary plate of *Iocrinus* consisted of R and × fused. This supposition, however, for which no other reason can be found, would lead to an inconsistency of a different kind. In no other genus of the Fistulata does the plate × support the ensuing plate (*t*) of the ventral tube on its left side: this fact was well known to Messrs. Wachsmuth and Springer in 1879, but they seem to have overlooked it in 1886.

Finally, the earlier stages of the evolution as set forth by Messrs. Wachsmuth and Springer entirely depend on the foregoing assumptions, to which such exception can be taken. And not only this, but they derive Dicyclica from Monocyclica and these again from Pseudomonocyclica. And again, starting from forms without pinnules, they pass through forms with pinnules back to forms without pinnules, and then to forms with pinnules again: this would have been all very well in 1879, but is totally inconsistent with the importance they attach to pinnules in 1886, when separating the Cyathocrinidæ from the Poteriocrinidæ.

What then are the true homologies and relations of the plates of the anal area? The so-called "azygos" plate I follow P. H. Carpenter in regarding as primitively the lower portion of the right posterior radial. Really there is little choice in the matter. Everyone is agreed as to which plate is the azygos in the various genera, and it is always found adjoining the right posterior radial. In the majority of the earlier forms it occupies a position immediately below the radial, e. g. *Iocrinus* (5), *Heterocrinus* (6), *Ectenocrinus* (7), *Anomalocrinus* (8), *Merocrinus* (11), *Dendrocrinus* (15), and in three of them it is exactly paralleled by other radial segments. It is hard to imagine that it began at one side of the radial in a few confessedly abnormal forms, that it suddenly found its way to a situation beneath the radial, and that it slowly worked its way back to its former position. Holding then the view that this plate is morphologically a radial element, I regret that the name "azygos" should ever have been applied to it. Words, we know, have a powerful, though often unconscious, influence on thought, and it occurs to me that the selection of this word by Dr. Carpenter led Messrs. Wachsmuth and Springer to their idea that it was a primitive independent element of the dorsal cup. Dr. Carpenter tells me that he followed E. Billings; but a reference to Billings * shows that he spoke quite correctly of "azygos interradials" or more correctly still "the plates of the azygos interradius." With equal correctness one may speak of an "azygos radial"; but the plate in question although originally a radial is certainly not the azygos radial, for that is in the anterior radius. I shall therefore drop the term "azygos" as either meaningless or misleading, and shall call the plate the "Radianal": this name should satisfy those who regard the radial as derived from the radianal, no less than those who prefer with me to follow Carpenter. In the diagram and formulæ I shall designate it R′ instead of Az.

The next plate to be considered is the "special anal" plate, hitherto designated ×; I shall retain this sign as appropriately suggestive. Now, taken as proven the correctness of Carpenter's views as to the radianal, we shall incline to regard those forms as primitive in which the radianal is more of a radial and less of an anal, in which it is not in an asymmetrical position but corresponds to the other lower radial plates. Such forms are *Iocrinus* (5), *Heterocrinus* (6), *Ectenocrinus* (7), *Anomalocrinus* (8), and *Merocrinus* (11). Now in all these forms × is supported by R and does not touch R′. Obviously then × is not derived from R′, but originates above R, and on its left side. By parity of reasoning we assume the next stage to be represented in such forms as *Hybocrinus* (?) (3), *Ottawacrinus* (12), *Dendrocrinus* (15), and *Homocrinus* (16), since in them R′ is rather more asymmetrical. In these × has passed down from above R and now rests with its lower half between the right and left posterior radials, being supported partly by R′ and partly by the basal. *Carabocrinus* (13), *Botryocrinus* (30), and similar forms are, as all acknowledge, the next stages in the shifting of the radianal; in these × has sunk still lower into the dorsal cup and is now entirely in a line with the radials. The great increase in size of × in some of the Botryocrinites and Cyathocrinites does away with the need for a radianal, and it consequently disappears; this does not affect the argument. In *Parisocrinus* (25) and *Euspirocrinus* (17) among pinnuleless forms, and in the Poteriocrinites (26, 27), another change has taken place; the radianal has passed through a revolution of 90°, and the lowest plate of the ventral sac (*t*) has sunk down between R and ×. Further than this it is needless to follow the process; this is enough to show that the course of

* 'On the Crinoideæ of the Lower Silurian Rocks of Canada, Canadian Organic Remains,' Decade iv. pp. 23-24 et passim, Montreal, 1859.

evolution has been a gradual sinking of the plates supporting the ventral sac into the dorsal cup. It is therefore perfectly logical to conclude that the original position of × was, where we see it in *Iocrinus* and *Merocrinus*, resting on the left upper slope of either the right posterior radial or its costal. To these earlier forms then we must turn to discover its homologies, and we immediately see that in size and position it is just like the adjacent arm-plate. Further the series of ossicles that follows it in many forms can hardly be distinguished from a brachial series; e. g. *Iocrinus*, *Merocrinus*, *Heterocrinus*. This view is confirmed by the evolution of the Calceocrinidæ as gathered from a recent paper by Dr. Eugene N. S. Ringueberg* ; in this family the earliest genus *Castocrinus* (Pl. XIV. fig. 9) shows a series of anal plates supported by the first costal of the left posterior radius, which is exactly comparable to the arm-bearing costal of the right posterior radius; *Proclivocrinus* (Pl. XIV. fig. 10) shows the intermediate stage between this and *Calceocrinus* (Pl. XIV. fig. 19). There can be little doubt that there is here presented the whole process of the transformation of an arm into a support for the ventral sac; the ancestor of *Castocrinus* must have had simply 5 arms. It will be noticed that in *Castocrinus* the anal plates arise from the left posterior arm and not from the right (I have assumed that Dr. Ringueberg's figures are not reversed, in the text he makes no mention of "right" or "left"), consequently I merely adduce the case to show the possibility of the process and the tendency of the Fistulata to accomplish it, if not by one means, then by another. To the exact homologies of the plates in the Calceocrinidæ I shall return when dealing with that family; I agree with Dr. Ringueberg in his rejection of Wachsmuth and Springer's nomenclature, but differ from him on a few points (see Pl. XIV. figs. 9, 10, 19). My conclusion therefore is that × originated as a plate morphologically corresponding to an ordinary brachial; and, for this reason, I propose to distinguish it as the "Brachianal."

The Brachianal and the Radianal are not only morphologically distinct, but they were evolved in fulfilment of distinct physiological aims. Their differing functions have already been alluded to; the brachianal primitively serves to support the ventral sac, while the radianal serves to enlarge the space between the right and left posterior radii. Of course the radianal does come to share in the support of the sac, when *t* sinks down on to its summit; while the brachianal, as it sinks and widens, does its part in enlarging the anal area.

* "The Calceocrinidæ &c.," Ann. N. York Acad. Sci. vol. iv., Article xvii. plates x. and xi. 1889.

But in the beginning, physiologically no less than morphologically, the two plates were distinct.

It will be observed that the position now taken with regard to the brachianal is not precisely that held by Messrs. Wachsmuth and Springer in 1879. They then inclined to regard the whole ventral sac as a metamorphosed arm, and, oblivious of the fact that *Iocrinus* possessed no pinnules, they compared the structure in that genus to a series of brachials supporting coalesced pinnules. This view is as unnecessary as it is untenable. The brachianal itself and the plates that follow it in regular series, which may be called 2nd, 3rd, &c. brachianals, are indeed to be regarded as brachials; but the remaining plates of the sac are nothing more than plates deposited in an extension of the ventral perisome. Such an extension of the ventral perisome up an arm is no uncommon thing in Palæozoic Crinoids; *Onychocrinus* is especially characterized by it, while in the Fistulata it is well shown by the common *Botryocrinus* of Dudley. Even more to the point is Angelin's description of *Cyathocrinus* (= *Gnorimocrinus*) *interbrachiatus* *:—" Basis tubi ventralis cum brachio connata," and the accompanying illustration.

What light the foregoing explanation of the anals of the Fistulata may throw upon the anal plates of Crinoidea in other suborders cannot here be considered. There is no doubt something to be said for applying it to the Ichthyocrinidæ, while in *Thaumatocrinus* the peculiar anal *appendage* may represent a series of brachianals that have lost their connexion with the anal tube. But in these forms the presence of interradials complicates the problem. Often too has the anal series of *Reteocrinus* and allied genera been compared to a 6th arm; but even accepting that view there would be no actual homology between brachianals derived from the right posterior radius, and brachianals derived from a posterior radius unrepresented in the Fistulata. Until then I have carefully examined all the variations of the anal area presented by other Crinoids I can express no opinion on this matter. My present business is with the classification of the Fistulata.

* 'Iconographia Crinoideorum,' p. 23, pl. xxix. fig. 78.

INDEX TO GENERA.

N.B.—The numbers refer primarily to the figures on the Plate, but when the name itself does not occur on the Plate, then the number refers to the note on the figure. The more prominent synonyms are given. Many genera that have been reckoned as Fistulata are now referred elsewhere.

EXPLANATION OF PLATE XIV.

(Illustrating the structure of the Dorsal Cup in the genera of Fistulate Crinoids.)

With the exception of the bottom line the figures follow each other in four vertical rows; three fourths of the bottom line is occupied by the Calceocrinidæ and Catillocrinidæ. Each row again is divided into five vertical columns: the first column on the left contains the simple generic diagrams; the circlets of radials, basals, &c. are indicated by letters placed on the left, and in some cases where any doubt might arise letters are inserted in other positions, but this is only done where all writers are agreed as to the homologies and the anal plates are never lettered: the next four columns contain diagrams of the anal plates and the posterior radial; these are lettered in accordance with the different views as to their significance. The second column contains the views of Wachsmuth and Springer in 1879 (figs. 3, 5, 6, 7, 8, 15, 16, 17, 25), the third column those of P. H. Carpenter in 1882 (figs. 1, 2, 3, 4, 5, 15). The views which these authors then held as to other genera were not definitely expressed by them, but they may easily be inferred from those that are given. The fourth column gives the latest views of Wachsmuth and Springer (1886), which it is presumed they still hold (all figs. except 9, 10, 12, 14, 19, 28, 29, 31). In the fifth column are indicated the views that seem to me more probable.

In each generic diagram the Left Anterior Interradius is on the extreme left and the Anterior Radius is on the extreme right: thus the position of the Posterior or Anal Interradius is always the same.

Explanation of the Lettering.

IB. Infra-basal.
B. Basal.
R. Radial.
C. Costal or Brachial.
R×. Lower half of a bisected Radial.
R′. A R× that has assumed anal functions, P. H. C.; Radianal, F. A. B.
Az. Azygos, W. & S.
×. Special anal plate, W. & S.; Brachianal, F. A. B.
t. First plate of tube, W. & S.; Second Brachianal, F. A. B.

Notes on the Figures.

1. *Hoplocrinus dipentas.* The type specimen differs in its anal area from the variety shown in fig. 2. The specific name is given here, as in all cases where the generic diagram has been taken from one species more than another.

3. *Hybocrinus. Hybocystis* is of essentially similar structure in the anal area.

4. *Baerocrinus.* The cracked lower right-hand corner of the R. post. Radial has been with insufficient reason regarded as an anal opening.

6. *Heterocrinus.* This=*Stenocrinus* of W. & S., a genus founded on the type species of *Heterocrinus, H. heterodactylus. Ohiocrinus* is of essentially similar structure in the anal area.

7. *Ectenocrinus* of S. A. Miller=*Heterocrinus* of W. & S. Type is *Heterocrinus simplex*, Hall. *Herpetocrinus* appears to be closely allied to this, but structure is uncertain.

9. *Castocrinus*, Ringueberg.
10. *Proclivocrinus*, Ringueberg.
W. & S. have as yet had no opportunity of expressing their opinion on these forms, which are alone enough to upset their published views.

12. *Ottawacrinus.* The view of Mr. Walter Billings *may* be correct, but mine is far simpler and equally probable.
13. *Carabocrinus. Suppl*=a supplementary radianal or basal.
14. *Thenarocrinus callipyge.* Both genus and species are as yet undescribed, so that no opinions have been expressed; the genus can be recognized from the figure but not the species. I have, however, given the proposed specific name of the type for reasons indicated under (1).
17. *Euspirocrinus. Closterocrinus,* Hall, is very doubtful but probably allied to this.
20. *Cyathocrinus. Sphærocrinus,* if it be an independent genus at all, *Streptocrinus* (W. & S. = *Ophiocrinus,* Angelin), and *Arachnocrinus* have the same structure in the anal area.
21. *Gissocrinus. Lecythocrinus,* Müller em. Zittel, appears to resemble this in dorsal cup.
22. *Achradocrinus. Hypocrinus Schneideri,* Beyrich ("Ueber eine Kohlenkalk-Fauna von Timor," Phys. Abh. d. k. Ak. d. Wiss. Berlin, 1864, pp. 83–84, pl. ii. figs. 16 *a, b, c*), appears to differ from this only in having 3 IB instead of 5.
23. *Codiacrinus.* The * marks the posterior interradius, and position of ×. *Lecythiocrinus,* White, is of the same structure, and is probably a synonym.
24. *Belemnocrinus. Holocrinus* resembles this, but no anal plate has been described. It was probably present in youth and atrophied in adult.
26. *Poteriocrinus.* The genera *Scaphiocrinus, Scytalecrinus, Decadocrinus, Woodocrinus, Cœliocrinus,* and *Hydreionocrinus,* while differing in arm-structure and general form, have all a similar structure in the anal area. *Philocrinus,* de Kon., is probably a *Woodocrinus.*
27. *Zeacrinus* only differs slightly from *Woodocrinus*; the depression of the dorsal cup produces a more curved outline of the anal plates.
28. *Mycocrinus.* The grooves at the top are where the arms articulate.
30. *Botryocrinus. Barycrinus, Vasocrinus,* and *Sicyocrinus* have a similar structure in the anal area. In a few species the Radianal is very small and may even become obsolete.
31. *Oncocrinus bucephalus.* See remarks on (14). *Cyrtidocrinus,* Angelin, is very doubtful, but seems like this.
34. *Cromyocrinus.* The unstalked *Agassizocrinus* has a similar arrangement of anal plates. In *Edriocrinus* there are no IB; B are anchylosed; × in line with R but narrower, supports a small plate; ventral sac unknown.
36. *Graphiocrinus.* In *Bursacrinus* the Brachianal extends as in *Phialocrinus,* Trautschold non Eichwald (37), to the lower portion of the costals. *Synyphocrinus,* Trautschold, is in W. & S.'s opinion a synonym of *Bursacrinus.*
39. *Erisocrinus. Stemmatocrinus* only differs in that its IB are anchylosed into a single plate. *Encrinus* and *Dadocrinus* have as yet shown no trace of any anal plate; in other respects their dorsal cup resembles that of *Erisocrinus.*

XLIV.—*Descriptions of new Species of East-African Butterflies.* By Emily Mary Sharpe.

Miss Jackson has entrusted to me for description some specimens of butterflies recently collected by her brother, Mr. F. J. Jackson, the well-known African explorer. During the journey which Mr. Jackson has recently made, as leader of the first caravan sent by the British East-African Company into the interior, he obtained a considerable number of Lepidoptera, which he will fully describe on his return to England, but meanwhile, by the desire of his sisters, I describe some of the novelties.

Mr. Jackson's collection was principally made in the Ukambani country, and as he is now in the Victoria Nyanza district we may expect further consignments of interest. Several species were obtained in the Ulu Mountains which are identical with others from Kilimanjaro in the British Museum, and my father tells me that this is the case with the birds.

I have to acknowledge with many thanks the kind help which I have received from Mr. A. G. Butler and Mr. W. F. Kirby in the determination of the species.

Fam. Acræidæ.

Genus Planema.

Planema Jacksoni, sp. n.

Similar to *P. montana*, Butler, from Kilimanjaro, but differs in having the hind margin of the hind wing orange-rufous, whereas in *P. Jacksoni* the black border extends along the whole of the hind margin. In the colouring of the hind wing *P. Jacksoni* resembles *P. gea* of Fabricius, but it has a greater extent of broad black margin extending to the apex of the submedian nervure. In the colouring of the fore wing *P. Jacksoni* approaches *P. gea*, but has a much greater extent of orange-rufous, a band of which colour traverses the wing and nearly touches the broad extent of orange-rufous on the inner margin of the wing, being only separated from it by a line of black at the extremity of the lower median nervule.

Fam. **Pieridæ.**

Teracolus bifasciatus, sp. n.

Similar to *T. eione* (*cf.* Butler, P. Z. S. 1876, p. 144), but having the orange patch divided in two by a series of confluent black spots, increasing in size to the last but one. It differs also in the second black band on the hind wing, which encloses a very distinct patch of white near the upper hind margin of the latter. *T. bifasciatus* has one black spot at the end of the cell. There are several other minor differences, the present species having more orange markings than *T. eione*, and the tint of the under wing in *T. bifasciatus* inclines to a pale olive-green colour.

Teracolus Jacksoni, sp. n.

Similar to *T. Thruppii*, Butler, but larger, and having only four long red spots on the fore wing. In *T. Jacksoni* the black band which occupies the greater part of the inner margin of the fore wing is connected with the black apical markings. The black band on the hind wing is much broader and continuous, and has not the white patch which *T. Thruppii* shows on the inner portion of the posterior margin. The shade of the under surface of the wing in *T. Thruppii* is more of a yellowish white, while in *T. Jacksoni* it is decidedly green.

Pinacopteryx nigropunctata, sp. n.

Similar to *P. pigea*, but with a black border along the greater part of the costal margin, and having a very distinct black edging round the apical portion of the fore wing; the hinder wing having a distinct black spot distributed along the hinder margin at the end of each nervule. The under surface is very different from that of *P. pigea*, being faintly but distinctly spotted with black on the hinder wing, and having two distinct black spots on the fore wing—one small one at the apex of the discoidal cell, and another larger one above the third median nervule in the centre of the fore wing.

BIBLIOGRAPHICAL NOTICES.

A Catalogue of British Fossil Vertebrata. By ARTHUR SMITH WOODWARD, F.G.S., and CHARLES DAVIES SHERBORN, F.G.S. 8vo. xxv & 396 pages. Dulau and Co., London: 1890 (January).

THE Introduction gives a reasonable apology for the Vertebrates here catalogued being restricted to Britain, because British Palæontology may be taken as an epitome of that of the whole world; and, we presume, because a full European, and much more a world-wide, list would have little chance of being prepared and published just now. Earlier catalogues of more or less similar character are then mentioned; and, taking the geological formations in order from below upwards, the authors give historical notes on the localities, the finding, and the possessors of the most remarkable or interesting of the Vertebrate fossils either recorded or known to have been collected. At page vi it should have been stated that, although the Rev. W. S. Symonds gives in his 'Records of the Rocks,' 1872, p. 184, probably trusting to memory, the credit of discovering the oldest British Fish to Mr. J. E. Lee, and however the specimen referred to may be labelled, yet Mr. J. W. Salter describes it in the Ann. & Mag. Nat. Hist. July 1859, as having been lately found by Mr. Robert Lightbody (the well-known geologist, then living at Ludlow), when in company with Mr. Lee, of Caerleon, and as being in Mr. Lightbody's collection at that time. So also Mr. G. Augustus Coombe ought to have been mentioned in connexion with Mr. Dixon at p. xvii, and Mr. Simmons as a careful collector of Chalk fossils at p. xviii. The method of the arrangement of the names in the Catalogue, the meanings intended in the use of different kinds of lettering for accepted genera and species, for synonyms and cross-references, and for the known localization of type specimens (that is, such as were originally used for description, not necessarily zoological types), are carefully indicated, and the names of numerous kind friends, advising and helping, are mentioned at pp. xxiii and xxiv.

Next follow five pages of the valuable results of careful bibliographic industry, by Mr. W. H. Brown, in determining the dates of publication of the parts and plates and supplemental sheets of the 'Recherches sur les Poissons fossiles,' by Louis Agassiz, Text, vols. i.–v., and Atlas, vols. i.–v. (1833–44), giving the right dates of publication for the genera and species described and figured therein; also of his 'Monographie des Poissons fossiles du Vieux Grès Rouge &c.,' Text and Atlas (1844–45). The dates of the publication of Sir Richard Owen's 'Odontography' (1840–45) have also been supplied by the same industrious bibliographist at p. xxix.

"A Table showing the Stratigraphical Distribution of the Genera of British Fossil Vertebrata," including a few known but not yet described, follows at pp. xxx–xxxv.

The rest of the book consists of the Catalogue itself, which demands the best attention and is worthy of the highest praise and recommendation that we can offer. It is a model for scientific bibliographists, thoroughly and conscientiously worked out in every respect, both as to literary and biological accuracy; and herein it stands high as a worthy successor (though within geographical and palæontological limits) to H. G. Bronn's well-known 'Index Palæontologicus.'

I. The Fishes (Pisces) have 198 pages, including a page of notes of their doubtful specimens and unknown species. II. The Amphibia and their miscellaneous fragments have 10 pages. III. The Reptilia, with their miscellanea and Ichnites, occupy 92 pages. IV. The Aves and their miscellaneous entries have 9 pages. V. The Mammalia and their miscellanea 84 pages. There are also additional notes on localities, fishes, reptiles, &c. at pages 395 and 396.

As the Mammalia occupied only six pages in Morris's 'Catalogue of British Fossils' in 1854, and the whole Vertebrate group only forty-nine pages, we readily see how the number of known fossil forms has increased since that date. The more elaborate synonymy, however, partly from the more liberal plan adopted and partly from accumulation of descriptive memoirs, has had some influence in this necessary enlargement of the Catalogue.

What we have to find fault with is—(1) The absence of initial capitals to proper names and their adjectives, whereby much is lost of the history of the species, especially to beginners. Why such ultra-pedantic decapitation has ever been recommended it is difficult to say, except that the old Romans had their writing all made in letters of one size, and that modern printers have to reach a little further for "capitals" than for "lower-case" letters. The Linnean plan of giving capitals even to common nouns, if used for the species, as well as to proper names, is preferable, for it helps amateurs and beginners, and the lists have a less dull and formal appearance. (2) The frequent and arbitrary change of an author's terminology when the specific name, being in the genitive case, has ended with "i i," which termination is euphonious, good enough in itself, and quite in accordance with Latin names, of which as many end in "ius" as in "us." Uniformity cannot require the change, for there is no need of uniformity at all in this matter, any more than with the unfortunate guests of Procrustes. Curiously enough, when this change is made and noticed in the Catalogue, the *original* "i i" are placed in square brackets, thus [ ], as if this were the correction of a mistake, whereas it is correct and true by the right of the author of the specific term. (3) That *aspis*, as well as *lepis*, is really feminine, though used as a masculine word, might have been noticed at p. 395. (4) Excepting a pedantic "*levesiensis*" instead of "*Lewesiensis*," an oversight in not giving E. Charlesworth the credit of being the first to name specifically *Coryphodon Colchesteri*, and the above-mentioned errors of judgment in occasional pedantry as to forms of nomenclature, we find no fault with this remarkably perfect and well-printed Catalogue.

Its clear and faultless printing on good paper, the trustworthy authority for the determinations, and the elaborate care taken with synonyms and localities, altogether make this book handy, easily consulted, and of exceeding value—indeed indispensable—to all geologists interested in or occupied with Vertebrate Fossils.

North-American Geology and Palæontology for the use of Amateurs, Students, and Scientists. By S. A. Miller. Large 8vo, pp. 664. Cincinnati, Ohio: 1889. Dulau and Co., London.

The first edition of this work was published in 1877 and duly noticed in the Ann. & Mag. Nat. Hist. ser. 5, vol. i. (January 1878) pp. 99–101. A "second edition" (so called, but in reality only a Supplement) was published early in 1883 (with a short preface, consisting mainly of extracts from letters of approval) and bound up together with a reissue of the first edition and an index to both in the same volume, making 334 pages (88 more than the first edition). The third edition, now before us, consisting of 664 pages, takes on a new feature by the reproduction of a great many (1194) woodcuts illustrative of Palæozoic genera and species found fossil in Canada and the United States. Eighty-five pages are occupied with an extended notice of Geology in general and the geological structure of North America in particular, worked up from the Reports of various State Surveys, which was confined to nineteen pages in the first edition. On the other hand, Prof. E. W. Claypole's essay on the "Construction of Systematic Names in Palæontology," pp. vii–xv in the first edition, has been modified into eleven dogmatic pages (90–100) on "Nomenclature."

Introductory remarks and classifications are given for both the Vegetable and Animal Kingdom and for the Classes and Orders as far as their Palæozoic members are concerned. In the Molluscoida only the Bryozoa [Polyzoa, Busk] have a place, the Brachiopoda being relegated to the Mollusca.

Diagnoses of the genera are copied or attempted throughout, and many new genera and species, determined by the author himself, are included with figures.

It would have been well had the author given his attention to all the critical remarks offered in the review of his book in January 1878. We might even now repeat much of what was there stated, especially about diphthongs being often ignored and words and references in German and French being printed without a fit knowledge of these modern languages. Indeed, when the reader refers to the remarks on *Orophocrinus* versus *Codonites* at p. 265, he finds not only a characteristic sample of how German words are misprinted, but we see a sad example of narrow, dogmatic, and invidious treatment of the German language, of a German scientific periodical, and of a German palæontologist!

We think that Mr. S. A. Miller has acted very wisely in omitting his etymological explanations of the meaning of specific names from the text, for very many were execrably bad in the earlier edition, and might have unfortunately been repeated even now; for we still see here and there the ugly mark of the illiterate amateur—for instance, where *lepas* in *turrilepas* is "a scale," and where such a derivation as *lepis*, a scale, and *dittos*, double, is given for *Leperditia*, which is really derived from the name of M. Leperdit, of Rennes. In this instance, as in others, we see that the author has not referred to the original nor to some later accounts of the genus. Indeed, it seems probable that the author's personal researches in palæontological books and scientific periodicals, whether British, French, or German, have been too limited for any one presuming to treat so extensively of fossil organisms as this Catalogue is supposed to do. The book is designed on a good basis, and doubtless this edition is better and therefore more useful than its predecessors; but the author's more accomplished friends, of different specialities, might aid him very much both philologically and palæontologically in a future revision of his Catalogue.

The hard pedantry of refusing initial capitals in specific names, of having only one letter "i" in the genitive masculine, of dogmatically altering *grapsus* (in combination) to *graptus*, of ignoring the masculine gender of the Latinized words *cheilus* or *chilus*, *rhynchus*, and *phycus* (in combination), because the Greek forms are neuter, is not good even in the dog-Latin of modern naturalists.

Although "Students and Scientists" may escape unhurt among the errors and weaknesses of this Catalogue, we are sorry for the "Amateurs," led by an amateur who tells them (in his Glossary, pp. 629 *et seq.*) that *ægilops* is "an acorn," *altilis* "flattened," *aucella* "a little bird," *bellulus* "very pretty," *breviusculus* "very short," *cerasiformis* "like a dried cherry," *dikrocheilus* "two-edged," *euginum* "fertile," *insectus* "uncut," *mummiformis* (!) "resembling a mummy," *temerarius* "accidental, casual," *vadosus* "full of shadows," and above all "*gracilius, a, um,*" "*majus, a, um,*" and "*minus, a, um,*" the neuter comparative forms of *gracilis, magnus*, and *parvus*! Had he given us also *plus, pla, plum*, he would have made the series nearly complete!

A Catalogue of North-American Palæozoic Crustacea, confined to the non-Trilobitic Genera and Species. By Anthony W. Vogdes. Printed in advance of vol. v. no. 1 of the 'Annals of the New-York Academy of Sciences.' 8vo. 38 pages, 2 plates, and some woodcuts. Author's edition. Fort Hamilton, New York Harbour, November 1889.

A systematic arrangement of the genera under orders and families occupies five pages and a half, and the annotated catalogue of the American species follows, with nine woodcuts (mostly outline diagrams) of types and two lithographic plates, one of them illustrating Xiphusures and Eurypterids from a plate in Dr. H. Woodward's memoir, 1867, and the other Ostracods and Phyllopods from T.

Rupert Jones's plate in 1870. This is a well-intentioned work, carefully planned, but not quite correctly carried out, by the industrious and, indeed, enthusiastic author. Some verbal errors, false concords, and occasional errors in the arrangement are met with; but we recommend it for the use of students of fossil Crustacea, if cautious in verifying references, wording, and classification.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

January 8, 1890.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.

The following communication was read:—

"On some British Jurassic Fish-remains referable to the Genera *Eurycormus* and *Hypsocormus*." By A. Smith Woodward, Esq., F.G.S.

Hitherto our knowledge of the Upper Jurassic Fish-fauna has been mainly derived from specimens found in fine lithographic stones, where the various elements are in a state of extreme compression. Within the last few years remains of similar fish have been discovered in the Oxford and Kimeridge Clays of England, and these are of value for precise determination of certain skeletal features in the genera to which they belong.

The Author described *Eurycormus grandis* from the Kimeridge Clay of Ely, a large species which makes known for the first time the form and proportions of several of the head-bones in this genus. A technical description of all the bones the characters of which are distinguishable was given, and the Author concluded that there is considerable similarity between the head of *Eurycormus* and the recent Ganoid *Amia*, even to minute points of detail.

He further described *Hypsocormus tenuirostris* and *H. Leedsii* from the Oxford Clay of the neighbourhood of Peterborough, the osteology of this genus not having as yet been elucidated. Portions of the jaws have been discovered, affording valuable information as to the form and dentition of the principal elements.

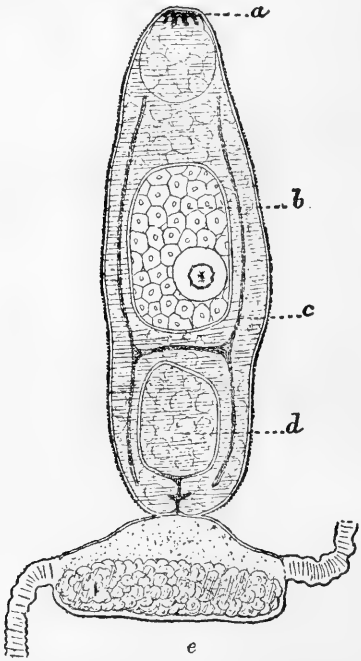
These jaws are not precisely paralleled by any other Jurassic genus, though they possess a resemblance to *Pachycormus*, as also to the Upper Cretaceous genus, *Protosphyræna*.

MISCELLANEOUS.

On Bucephalus Haimeanus. By M. L. Huet.

The animals belonging to the genus *Bucephalus* were first noticed by von Baer in *Anodonta anatina* and by Pagenstecher in *Unio pictorum*. This freshwater species was named *Bucephalus polymorphus*. In 1854 Prof. de Lacaze-Duthiers described a marine species, *B. Haimeanus* (Ann. Sci. Nat. 4e sér. tome i.), which he met with at the Balearic Islands, at Mahon, and also at Cette, in *Ostrea edulis* and *Cardium rusticum*. The author has frequently found the latter or a nearly allied species in *Cardium edule*, inhabiting the same regions of the body of the host, and presenting the same morphological characters.

The cockles in which the parasites are found have a sickly aspect, by which they may be easily recognized; their abdomen, which is normally firm, yellow, and opaque, becomes soft and whitish; "it has the aspect of an œdematized tissue, infiltrated with fluid" (Lacaze Duthiers, *l. c.*).



Bucephalus Haimeanus from *Cardium edule*.
a. Oral cup. *b*. Digestive cavity. *c*. Genital apparatus. *d*. Excretory organ. *e*. Caudal appendage.

On opening such a *Cardium* the lacunar tissue representing the general cavity is seen to contain an immense number of white filaments, several centimetres in length, branched, knotted about the intestinal loop, and pushing away the hepatic, renal, and genital glands; the atrophy of the last-named is especially marked.

These tubes, the *sporocysts,* cannot move, but they possess a certain amount of contractility. Within them are Cercariæ in all states of development. These are described by Lacaze-Duthiers. In fact the author can detect scarcely any difference between the parasites found by the latter in *Cardium rusticum* and by himself in *C. edule.* The elongated flattened body is covered with a delicate membrane, finely striated transversely. At its narrower extremity is an unarmed mouth at the bottom of a sucking-cup. The author has observed no œsophageal tube, which is contrary to Lacaze-Duthiers's statement. In the middle region the body shows a closed cylindrical cavity lined with nucleated cells, and in this part there is also a second circular sucking-disk. The posterior part also has an interior cavity, smaller than that in the middle region, with which it has no communication, but having a cord running to an aperture at the base of the caudal lobe (see below). It is probably excretory. Between the anterior and posterior cavities there is a darker, granular, transverse band, from the lateral extremities of which similar bands are given off anteriorly and posteriorly, the whole representing a capital H. The author regards these as the first traces of genital glands.

The aboral extremity of the body bears a curious caudal appendage, composed of a voluminous median lobe, flattened transversely, and from which are given off on each side two filaments of great length and very contractile, capable of attaining many times the length of the body and then of retracting by rolling up.

Although during the months of November, December, January, and February this *Bucephalus* is to be met with in about 4 per cent. of the examples of *Cardium edule,* and a certain number of them always in the state above described, which the author regards as the adult Cercarian stage, the *Distomum* belonging to it could not be found in them; by the end of March all traces of the parasites disappear *.—*Bull. Soc. Linn. Norm.* sér. 4, vol. ii. p. 145 (1889), with a plate.

On the Formation of the Antherozoids in Eudorina elegans. By M. P. A. Dangeard.

The colonies of *Eudorina elegans* are composed of sixteen or thirty-two cells occupying the surface of a sphere, each possessing two long cilia, a nucleolated nucleus, an amyliferous corpuscle, and a lateral red point; the colony moves by the agency of the cilia; asexual reproduction takes place by repeated bipartition of the cells.

The sexual colonies are male and female, the latter closely resembling the ordinary vegetative colonies, except that the contents of the cells are more opaque and their number may be reduced to four. In the male colonies each cell by successive bipartitions gives origin to thirty-two or sixty-four cells which remain united in the same plane, forming yellowish disks, which escape and move through the water often for a considerable time; when one of them falls in with a female colony the antherozoids composing it are set free;

* In a subsequent note M. Huet records his observations upon another Cercarian parasite of *Cardium edule,* which he was also unable to trace to maturity.

they are very long, have two long cilia at their anterior extremity, and a very contractile plasma; finally they penetrate into the jelly surrounding the female cells or "oospheres," and the fusion of an antherozoid and an oosphere gives origin to an ovum, which becomes red in passing to the condition of latent life.

In *Chlamydomonas Reinhardti* the author has shown * that in two cells which conjugate to form an ovum the nuclei become fused together, and this is no doubt the case in *Eudorina*, although it has not been observed directly.

Besides the normal mode of formation of the antherozoids in *Eudorina* the author has observed another which he thinks serves to elucidate the value and signification of the sexual reproduction in some Volvocineæ. His observations were made in February upon cultures of about six months.

In a colony of 32 cells, when the division of the cells has advanced to the 8- or 16-stage, as the division does not follow a parallel course in all the cells, some will remain entire while others are already divided into 2, 4, 8, or 16. The division completed these cells arrange themselves as if to form an asexual colony, and then the following phenomena were observed, here given in the order of their occurrence.

On *Monday* the colony presented two mother-cells, A and B, each containing 16 elongated green antherozoids, moving briskly within the cavity containing them.

On *Tuesday* most of the antherozoids of A had escaped; those of B were still very active. In a third mother-cell, C, the still globular daughter-cells arranged themselves in accordance with a spherical surface and then began to move slowly within the cavity; they were green and possessed two cilia and a red point.

On *Wednesday* the antherozoids of B escaped; their plasma contracted with great facility, and, except in their green colour, they exactly resembled the ordinary antherozoids. In C the cells quickened their movements and became more elongated in form; in a fourth mother-cell, D, the daughter-cells also began to move.

The same phenomena occurred during the following days in each cell of the colony.

The author considers that these facts show clearly that in *Eudorina* the formation of a disk is not a necessary preliminary to the production of the antherozoids, but that green globular cells resembling the vegetative cells and oospheres may *directly* give origin to antherozoids; whence it follows that the sexual reproduction of *Eudorina*, and consequently of *Volvox*, is only an unimportant modification of the *isogamy* which is known to occur in some *Chlamydomonades*, in *Chlorogonium*, *Pandorina*, and *Stephanosphæra*.—*Bull. Soc. Linn. Normandie*, sér. 4, vol. ii. p. 124 (1889).

* Bull. Soc. Linn. Norm. 1887.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

No. 29. MAY 1890.

XLV.—*The "British Area" in Marine Zoology.* By the Rev. Canon Norman, M.A., D.C.L., F.L.S., &c.

I. *Definition of the British Area.*

The British Area may be defined at the south by lat. 49° 30′ N., which parallel, as it passes eastwards, should terminate at long. 5° 0′ W., that is, midway between the Land's End and Brest. From that point the midchannel must be the boundary round the south and south-east coast, until at lat. 51° 50′ N. long. 2° 30′ E. (nearly opposite the Naze) we obtain a mid-channel, whence that long. (viz. 2° 30′ E.) may be taken as the boundary through the North Sea and past Shetland. The northern boundary is more complex, but coming from the west by lat. 60° N. and proceeding eastwards we shall reach a point about midway between Cape Wrath and Faroe at long. 5° 0′ W.; thence a line must be driven direct north-east past Shetland until long. 1° 0′ W. is reached, whence it should proceed due east to join the eastern boundary already referred to, viz. long. 2° 30′ E. The western boundary has no defined limits; it is the slope of that part of the continent of Europe of which our Islands are the outliers, and descends to the base of the continent at 1500 fathoms.

II. *Reasons for the Adoption of this Area.*

The exploration of the sea around our Islands was until about twenty years ago confined to such investigations as could be undertaken by private individuals, and was consequently limited to the near waters of our shores and in shallow depths. In 1868 the first government expedition was, at the instigation of the Royal Society, undertaken; and from that time subsequent expeditions have searched, though as yet only tentatively and most imperfectly, the greatest depths which may fairly be regarded as within the British Area.

What must now then be regarded as the British Area? The answer involves the wider questions, What is the area of a continent? What of Europe?

The area of a continent cannot be geographically and scientifically regarded as limited to that portion which, at this particular geological epoch is, or, indeed, at any geological epoch was, uncovered by the sea and left dry. If a stone is placed in a vessel, and that vessel be partially filled with water, the stone does not consist of that portion still above the surface of the water, but embraces the part covered down to the base which rests upon the bottom of the vessel. Similarly, a continent is not limited to the subaerial exposed land, but includes its slopes and buttresses and base down to that depth where it meets and rises from the bed of the ocean.

Where, then, does a continent thus rise? Upon grounds about to be stated it is here argued that Europe and Africa, and probably it may be said all continents, rise from the oceanic bed at a depth of 1500 fathoms. If a good chart of the eastern North Atlantic be examined* it will be found that the abyss of the ocean ranges from 1500 to 3000 fathoms, which latter depth is not exceeded north of lat. 28° N.

We must first examine how far the theory here propounded is borne out by evidence, and to what extent depths under 1500 fathoms are found in the North-east Atlantic. The only cases as yet known of submerged areas not connected

* Admiralty Chart, "North Atlantic Ocean, Eastern Portion." The charts which illustrate the various British North Atlantic Expeditions should also be consulted, together with 'Den Norske Nordhavs Expedition, 1876–78,' xviii. B (1887); H. Mohn, 'Nordhavets Dybder, Temperatur og Strömninger.'

Similar conditions prevail off the east coast of North America down to Cape Hatteras. *Vide* Verrill, "Physical Characters of the portion of the Continental Border beneath the Gulf Stream" (Ann. Rep. Comm. Fish and Fisheries for 1882, published 1884); also A. Agassiz, "Three Cruises of the 'Blake,'" vol. i. (Bull. Mus. Comp. Zool. vol. xiv.) cap. iv., "Topography of the Eastern Coast of the North-American Continent."

with land and at less depths than 1500 fathoms are the following:—(1) The "Josephine Bank," to the west of Cape St. Vincent, 466 fathoms; (2) "Seine Bank," north-east of Madeira, 81 fathoms; (3) "Laura Ethel Bank," about long. 38° 50′ W., lat. 47° 0′ N., 36 fathoms; and (4) a sounding some 600 miles west of the Shannon, 1451 fathoms. *All other water at less than* 1500 *fathoms is connected with adjacent land by lesser depths.*

It is very interesting to follow carefully the 1500-fathom line as bearing upon submerged geography. The most remarkable fact it reveals is a vast elevated district connected with the Azores. This district extends some 600 miles east and west at the Azores, thence rapidly narrowing northwards it nevertheless apparently reaches more than 1000 in that direction, in fact right up to lat. 50° N. For the most part the depths range over this great region of elevation from 1000 to 1400 fathoms; but at the most northern point a sounding gives 625 fathoms, and near the middle 70 fathoms and 48 fathoms.

The Madeiras, Salvages, and Cape-Verd Islands are regions of elevation separated from the adjacent continent by depths exceeding 1500 fathoms.

If we now follow the 1500 coast-line along the continents of Africa and Europe some very remarkable facts come out. Commencing at the Gulf of Guinea, at Cape St. Paul, and proceeding thence up the whole of the African and European coasts until the English Channel is reached, we find that at *every single spot* soundings of 1500 fathoms, where given, are within 180 miles of land *, and that for the most part they are as near as 100, 60, or even 40 miles. To bring this fact home it may be thus put:—the mean distance of depths greater than 1500 fathoms from shore throughout this enormous extent of some 4000 miles of coast-line is less than that of Dublin from Liverpool! And according to the views here propounded this is all the extent seaward which naturalists living upon any part of it could claim as belonging to their area, so suddenly do the continents thus far north rise out of the abyss.

Immediately we reach the English Channel submarine Europe completely changes its facies and is extended greatly westwards. From the Land's End we have to go 300 miles west before even the 100 fathom depth is reached, and 120 more before the ocean bottom is attained. Off the west of

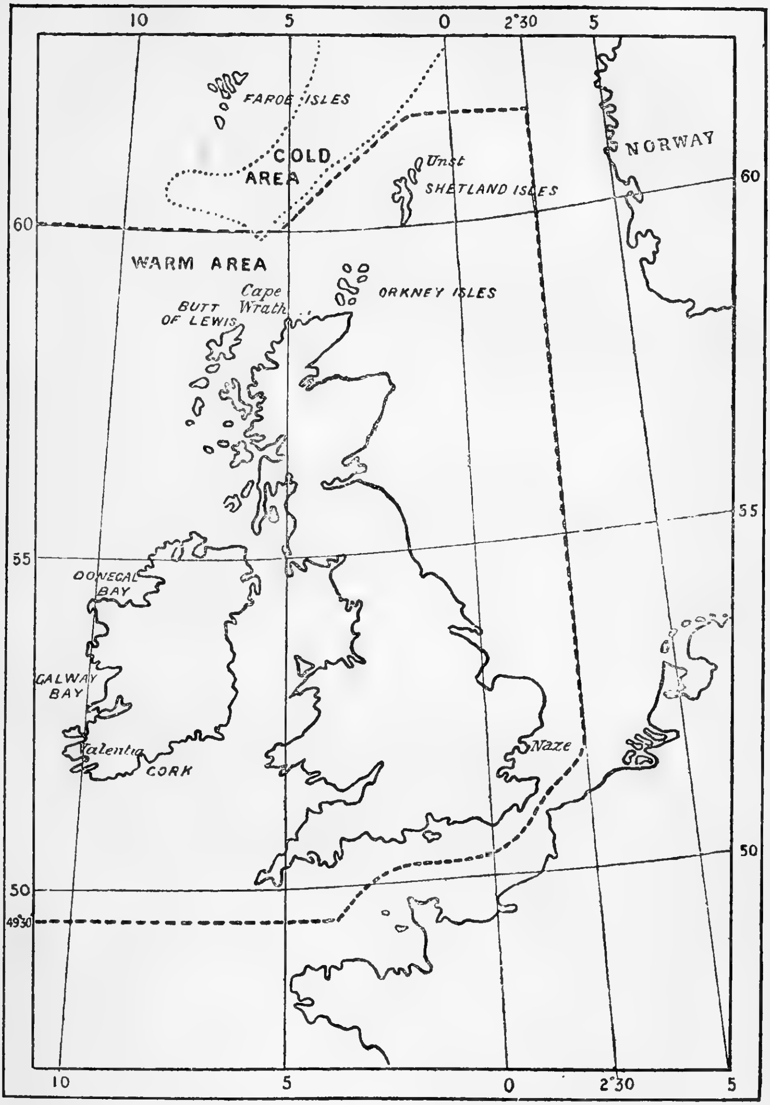
* Except where the Canaries are connected with the continent; but to the west of these islands the incline is excessively steep, plunging into 2410 fathoms within 60 miles of Palma.

Ireland peculiar features present themselves. At some 330 miles west of the mouth of the Shannon the depth has increased only to 650 fathoms, but beyond and so close to this sounding that the recording figures meet on the chart we find 1570 fathoms. In fact here and opposite the greater part of Ireland the continent is supported at its base on huge precipitous buttresses some 5400 feet high. Towards the north of Ireland the great abyss below these precipices trends towards land in narrow tongue-like form, so that a 'Porcupine' dredging at lat. 50° 24′ N., long. 15° 14′ W., gives 1630 fathoms.

Again proceeding northwards we find the area of submarine Europe vastly enlarged and stretching further and further westwards, and 13 degrees or, say, 780 miles are crossed before we can meet with a 1500-fathom sounding.

To the north of this again we can pass from the north of Scotland by the "Wyville-Thomson Ridge" and "Faroe Banks" to Faroe, and thence by the "Faroe Ridge" to Iceland in less than 300 fathoms, and in another 100 fathoms we find a passage from Iceland to Greenland, while the under 1500 fathoms area has enormous extension southward. This vast submerged continental land separates the basin of the Atlantic from that of the Arctic Ocean.

The mention of the "Wyville-Thomson Ridge" brings us to the explanation of the irregular northern demarcation of the British area indicated on the map and given in definition. The reason why this line of demarcation must be brought nearer to the Shetland Isles than midway to Faroe is as follows:—Crossing diagonally lat. 60° N. and running from the shallows of the British seas W. by N. there exists a narrow ridge, which separates depths of 500–600 fathoms of the Atlantic from similar depths of the Arctic Ocean, such great depths of these oceans here alone thus closely approaching each other. On the southern side of this ridge the waters are affected by the Gulf-stream, and at the bottom of this "warm area" at the depths mentioned the temperature is about 48° Fahr. The Gulf-stream coming against the ridge can only overflow it, and while the surface to the north of this ridge is thus warmed, the depths below in the "cold area" remain unaffected, and are at the low temperature of from freezing-point, 32° Fahr., to 33° Fahr. This "cold area," or most southern projection of the Arctic Ocean on the northern side of the "Wyville-Thomson Ridge," is known as the Faroe Channel, and has a somewhat boot-like form, widening beneath the ridge. Here its depth is 500–600 fathoms, thence the depth regularly and gradually increases northwards, until at the "Norway Deep" (about



The British Marine Area, showing its Southern, Eastern, and Northern Limits.

[The finely dotted line to the north indicates the boundaries of the "cold area" or "Faroe Channel."]

lat. 68° N., long. 2° W.), or the parallel of the Lofoten Islands, the great abyss of this part of the Arctic Ocean is reached in 2000 fathoms. Now the fauna of the "warm area" to the south of this ridge exhibits a more southern character, different from that of the "cold area" of the Faroe Channel, which latter is more arctic, and the British line of demarcation driven from long. 5° W. direct N.E. past Shetland is chosen for the purpose of excluding the "cold area," which belongs more properly to the Arctic Ocean generally and to Faroe in particular *.

In 1887 a committee was appointed by the British Association to consider the question of the British Area, and their Report (Brit. Assoc. Rep. 1888, p. 95) the following year is here given:—

"*Report of the Committee, consisting of* Canon A. M. Norman, Mr. H. B. Brady, Mr. W. Carruthers, Professor Herdman, Professor W. C. M'Intosh, Mr. J. Murray, Professor A. Newton, Mr. P. L. Sclater, *and* Professor A. C. Haddon (*Secretary*), *appointed for the purpose of considering the question of accurately defining the term 'British' as applied to the Marine Fauna and Flora of our Islands.*

"A circular giving in detail alternate boundaries for a British marine area, and maps and sections illustrating the same, was distributed to members of the 'British Marine Area Committee,' as well as to a large and representative number of naturalists interested in marine zoology. As was to be expected, the replies showed that great diversity of opinion exists not only as to the desirability of limiting a British marine area, but also as to how far such an area should extend.

"A tabulation of replies was subsequently forwarded to the members of the Committee, and the following statements appear to express the views of the majority:—

* The following Mollusca have occurred in the Faroe Channel which are unknown to exist south of the "Wyville-Thomson Ridge":—*Bela scalaroides*, G. O. Sars; *Buccinum hydrophanum*, Hancock, and its var. *Mörchi*, Friele; *Sipho lachesis*, Mörch; *S. turritus*, M. Sars; *S. Sabini*, Gray; *S. delicatus*, Jeffreys; *S. turgidulus*, Jeffreys; *S. concinnus*, Jeffreys; *S. hirsutus*, Jeffreys; *Mohnia Mohni*, Friele; *Rissoa arenaria*, H. & A. Adams; *Solariella obscura*, Couthouy; *Molleria costulata*, Müller; *Cyclostrema areolatum*, G. O. Sars; *C. rugulosum*, G. O. Sars; *Pilidium radiatum*, M. Sars; *Chiton arcticus*, G. O. Sars; *Lima excavata*, Fabr.; *Montacuta Voringi*, Friele; *Octopus arcticus*, Prosch; *O. piscatorum*, Verrill; *Tracheloteuthis Riisei*, Steenstrup.

"It may be desirable for the convenience of curators of museums and the compilers of faunistic works to limit a marine area, which may be more particularly described as 'British.'

"The British Marine Area may be conveniently subdivided into a shallow-water and into a deep-water district.

(1) "The 100 fathoms contour is a natural boundary line for the former off the north and west coasts of the British Islands for the following reasons:—1. It is defined on all charts. 2. The Admiralty soundings are very complete down to that depth. 3. The 100 fathoms line roughly corresponds with the beginning of the declivity of the continental plateau. 4. There is a marked change in the fauna about that limit. 5. Most of the dredgings of British naturalists have been taken within that contour.

(2) "The only boundary to the south and east is the half-way line between Great Britain and the continent; this should include the Dogger Bank.

"The above may be termed 'The British Marine Shallow Water District.'

(3) "The deep-water district of the British Marine Area may be regarded as extending from 100 to, say, 1000 fathoms —that is, to the commencement of the abysmal floor of the ocean. As these depths only occur off the north and west coasts, this region may be termed 'The British Atlantic Slope District.'

(4) "The Channel Islands lie outside the British Marine Area proper."

It will be seen that I was chairman of the above committee and Prof. Haddon its active secretary, who took great trouble in the matter. I was very much engaged at the time in matters other than scientific, and fear that my own views were not expressed to him with sufficient fulness and clearness. The fault was mine, not his; nor, indeed, had I studied the subject so fully then as I have subsequently. I then, however, dissented and must still dissent from the conclusions arrived at, but from no want of appreciation of the pains taken by Prof. Haddon. Still I think any one reading that Report can hardly regard it as altogether satisfactory, more especially as it seems to leave the matter undecided between a 100 and a 1000 fathoms limit. I have numbered the later paragraphs in order that they may be now briefly referred to.

(1) I cannot accept the proposition that "there is a marked change in the fauna" at about 100 fathoms. The fact is there is no marked change at that or any other particular

depth exceeding 20 fathoms. The changes in the fauna are gradual, and are to a great extent more effected by the nature or the temperature of the bottom than by the actual depth. There are only two natural limits to representatives of flora and fauna—1st the littoral, where there is alternation of submergence and exposure; 2nd, the termination of the Laminarian zone at 15–20 fathoms (commonly), where, with the cessation of Algoid growth, there is also necessarily a cessation of phytophagous animals. Secondly, I know no reason why the " 100 fathom line roughly corresponds with the beginning of the declivity of the continental plateau," more than any other depth does so.

(2) The eastern limit proposed in this present paper divides the "Dogger Bank;" but practically it is impossible to say from what exact part of the Dogger Bank Mollusca and other animals come which naturalists obtain through the instrumentality of trawlers or long-line fishers; but the so-called "Dogger Bank" shells do not really come from the shallow waters of the Bank, but from the "deeper water" which is within its British border, and to the north of it.

(3) The chief object of the present paper has been to prove that the "abysmal floor of the ocean" commences at 1500 and not at 1000 fathoms, and that depths of 1000 fathoms are not to be found on its floor. In the Report the only boundary given for the north is the 1000 fathoms limit; but in that direction no such sounding can be found until lat. 63° N. is reached. This is far into the Arctic Ocean, and brings us to a point nearer to Faroe or Norway than to Shetland, and although the slopes N. and W. of Shetland, which are those descending to the Arctic Ocean, must in some degree be embraced, it appears to me right that they should not be descended to such a depth as would be characterized by water at or nearly at freezing-point. The limit, as indicated in this paper, to the north does not descend to water deeper than 300–400 fathoms.

(4) The Channel Islands lie outside the British area proper, and belong geographically to France, the naturalists of which country do right in including them in their fauna and flora. As, however, they belong to us, and are a favourite and excellent collecting-ground for southern forms, it is convenient to students that their animals and plants should find a place in works on British Natural History.

I feel confident that when the enlarged British Marine Area is fairly realized it will act as a great stimulus to many naturalists, who restrict their studies to what is "British," to take means for its fuller investigation. A vast field remains almost unexplored around our coasts. That much more extended investigation should take place is of no small geographical as well as biological importance. In our knowledge of the contour of Europe beneath the sea we are far in arrear. The Americans have beaten us out and out. Few things attracted more attention at the Fisheries Exhibition than the admirable model of the North-east American ocean bottom, showing the descent of that continent into the abyss. Is it too much to hope that such further explorations may be conducted by our government as shall enable a similar model of our Marine Area to be placed at no distant period in the British Museum?

April 8, 1890.

XLVI.—*New Species of Indian Butterflies.* By Colonel C. Swinhoe, F.L.S., F.Z.S., &c.

Satyrinæ.

1. *Melanitis ampa*, n. sp.

♂ ♀. Upperside uniform pale brown; fore wing with two pale blackish-brown rounded spots, the lower the larger, placed midway between the end of the cell and the outer margin, one on either side of the third median nervule, the lower spot indistinctly centred with white.

Underside pale reddish brown, striated with grey; fore wing crossed by a straight brown band, from the costa more than one third from the apex to the hinder margin, which it does not reach, followed by a paler patch and a submarginal incurved row of five or six ocelli with white centres; hind wing with an outwardly curved brown band, from the costa just beyond the middle to the abdominal margin (which it does not reach) one third from the anal angle, followed by a pale space and a submarginal outwardly curved row of six ocelli with white centres; both wings broadly margined with brown; wings shaped much as in *M. aswa*, Moore; the grey striations and ocelli much the more prominent in the female.

Expanse of wings, ♂ $2\frac{1}{10}$, ♀ $2\frac{5}{10}$ inches.

North Kanara, July 1886.

Allied to *M. aswa*, Moore, with the pattern of the spots below as in *M. varaha*, Moore.

Nymphalinæ.

2. *Euthalia khasiana*, n. sp.

♂. Upperside of a uniform dark glossy olive-brown; abdominal margin of hind wing pale reddish brown; a few greyish-blue scales on the outer margin of hind wings towards the anal angle, obsolete in one example, the discoidal and adjacent markings, as also the double discal blackish lines, as in *E. appiades*, Mén.

Underside dusky ferruginous, with the inner and lower portions of the hind wing suffused with greenish grey; this suffusion blends into the dusky ferruginous colour of the rest of the wing, and in one example covers all the wing below the apical third; bands and markings similar to those of *E. appiades.*

Expanse of wings $2\frac{9}{10}$ inches.

Khasia Hills, 1888. Three examples.

Allied to *E. appiades*, Mén.; but the apex of the fore wing is more rounded, and it can at once be distinguished by the absence of the broad blue marginal band of the hind wing of that species.

3. *Euthalia rangoonensis*, n. sp.

♂. Very much like that sex of *E. kesava*, Moore, but is uniformly paler above, the discal greyish band broader, paler, and brighter, covering very nearly the whole of the outer half of the fore wing, leaving a thinner marginal brown band which is finely attenuated to the hinder angle and in many specimens does not reach it.

On the underside there is no appreciable difference, except that in *E. kesava* in all my specimens there is a black spot just below the cell where the first median branch is emitted, whereas in all the specimens of this species there is a distinct black ring with a smaller one below it, as in the female.

♀. Upperside pale olive-brown; five brown lines across the cell of fore wings and a twin brown ringlet and a transverse subbasal mark in the interspace below, with two brown ringed marks in the hind wing, as in *E. kesava* ♀; a broad greyish-white discal band across both wings, broadest on the upper radial vein, otherwise fairly uniform throughout, margined outwardly with dark brown and strongly dentated, sinuous inwardly and in places dentated, powdered in the central portions with pale olive-brown, which also suffuses the band towards its lower end on the hind wing.

Underside: fore wing pale greyish ochreous; hind wing bluish grey, with a little greyish-ochreous colour on the upper portion of the outer margin; the discal band as above, but margined on both sides with dark brown, white on fore wing and upper half of hind wing, the remaining portion being of the bluish-grey colour of the wing and very slightly irrorated in some of its central portions; discoidal and subbasal marks as in the male.

Expanse of wings, ♂ $2\frac{2}{10}$ to $2\frac{6}{10}$, ♀ $2\frac{9}{10}$ to $3\frac{3}{10}$ inches.

Rangoon, June, July, and August 1886. Many examples of both sexes.

Allied to *E. kesava*, Moore, much resembling that species in the male, but widely different in the female, especially in the size and shape of the discal band and in the blue coloration of the hind wing below. Undoubtedly the two sexes belong to one species, the markings being identical and all having been taken together.

4. *Euthalia laudabilis*, n. sp.

♂ ♀. Upperside bright metallic blue-green; a broad bluish-grey discal band across both wings, broad on the costa of the fore wing (which it does not quite touch) and gradually attenuated downwards towards the abdominal margin of the hind wing, near which it becomes more or less obsolete, its inner margin sinuous on fore wing; this band is bright and distinct in the female and indistinct and nearly obsolete in the male, except at the costa of the fore wing; fore wing with two discoidal black-lined marks, the upper part of the inner one centred with vermilion; hind wing with one black-lined mark; both wings with a submarginal lunular dark band and with the apex of fore wing suffused with blackish.

Underside bluish grey, with greyish-brown transverse fasciæ, one just beyond the middle and two submarginal and close together, the outer one lunular and nearly obsolete in the male; fore wing with discoidal marks as above; hind wing with two discoidal marks and two rings above them, the upper end of the inner discoidal mark and both rings being centred with vermilion.

Expanse of wings, ♂ $3\frac{6}{10}$, ♀ $4\frac{2}{10}$ to $4\frac{6}{10}$ inches.

North Kanara, May, June, and July 1886.

Allied to *E. evelina*, Stoll, who gives the locality as Bengal; but no other example appears to have come from that locality. Stoll's figure agrees with the Ceylon insect on the upperside, but on the underside it is without purplish and with pale spots on a dusky outer margin to both wings; both are widely different from the insect now described not only in the coloration being bright metallic blue-green instead of dull metallic golden-green, but also in the entire absence of the prominent discal band.

Pierinæ.

5. *Callosune alberta*, n. sp.

♂. Upperside pure white. Fore wing with the costal line blackish brown, accompanied interiorly with grey irrorations; basal area darkly irrorated with grey, a distinct greyish-brown mark at end of cell; a large carmine apical patch, with narrow blackish-brown outer border, running in on to the veins, which are also blackish brown, and with a broad, more or less suffused, blackish-brown interior band, which fines down the outer margin beyond the first median branch and sometimes to the hinder angle. Hind wing with the base slightly irrorated with grey; large blackish-brown marginal spots on each vein, pointed inwardly more or less.

Underside: fore wing white, costal and basal areas greenish grey; a brown spot at the end of the cell; apical area broad, rosy flesh-colour. Hind wing rosy flesh-colour, tinted with lilac; a brown spot with a red centre at the end of the cell; a discal band of spots with pale centres across both wings, touching the apical flesh-coloured space in the fore wing, well recurved on both wings, usually complete on the hind wing, often only faintly indicated in the first median and internomedian interspaces of the fore wing, sometimes obsolete there; in some specimens the spots on this band, especially on the hind wing, are confluent; two pale blackish-brown patches at the margin of the fore wing on the first and second median branches.

♀. Upperside much as in the female of *C. dirus*, Butler; the underside is, however, quite different, being coloured and marked as in the male, but with the colours and markings much stronger and darker.

Expanse of wings, ♂ ♀ $1\frac{9}{10}$ inch.

Karachi, October and November 1885.

Allied to *C. subroseus*, Swinh. (Proc. Zool. Soc. 1884, p. 443, pl. xl. figs. 6 and 7, ♂ ♀), but is more strongly marked above and below and differently tinted on the underside in both sexes, having the peculiar purplish tinting of some of the African species. I have 37 males and 8 females of *C. subroseus* and 14 males and 4 females of this species; they are near allies, but can hardly be seasonal forms of each other, as *C. subroseus* occurs more or less all the year round. I have taken it in every month of the year except September.

6. *Ixias alana*, n. sp.

♂ ♀. Upperside lemon-yellow. Fore wings with the basal and costal areas irrorated with greenish; costal margin black, suffused with greenish yellow, narrow in the male, broad in the female, suffused inwardly and filling up two thirds, sometimes nearly the entire cell; apical patch black, enclosing a broad orange belt (yellow in the female), divided by black veins into eight areas, the eighth area in the male being a small circle at the upper end of the cell, absent in the female, which has a narrower belt, and consequently a broader inner margin, which thickens much at the end of the cell, where it joins the costal band; there are also two large black spots in the two lowest areas of the belt; first and second median branches black, making a yellow spot in both sexes where the second median interspace commences. Hind wing with a broad marginal black band a quarter of an inch deep, a very little broader in the female than in the male.

Underside lemon-yellow in the male, chrome-yellow in the female, the male with a small blackish spot at the end of each cell; a blackish patch on the margin of the fore wing near the hinder angle and some slight greyish irrorations along the margin of both wings; female with the spot at the end of the cell in the fore wing and the patch near the hinder margin large, the latter running in well on the first median branch and narrowing down to the angle, with a discal row of blackish spots running upwards from the patch one in each interspace, lessening in size and paling in colour as they ascend. Hind wing with a small spot at the end of the cell, a blackish patch at the apex, and a few indistinct blackish spots in the disk; both sexes with minute black marginal points in the centres of the interspaces.

Expanse of wings, ♂ ♀ $2\frac{4}{10}$ inches.

Maldah, July 1886; ten pairs. Barrackpore; six pairs.

Allied to *I. colaba*, Swinhoe (Proc. Zool. Soc. 1885, p. 142, pl. ix. fig. 6); differs above in its much deeper black marginal border, and below in having a black patch near the hinder angle on the fore wing of the male and in the bright chrome-yellow colour of the female, the female of *I. colaba*, of which I have a fine series, being very pale yellow.

7. *Ixias lena*, n. sp.

♂. Upperside pale bright primrose-yellow. Apical half of fore wing brownish black, enclosing an ochreous-red band, divided by the veins into eight areas, the eighth area being a small space at the upper end of the cell, just above the square knob of the black inner margin; costal border and basal area irrorated with greenish grey. Hind wing with the base very slightly suffused with grey, and with a marginal brownish-black border about a quarter of an inch deep near the apex, and attenuated hindwards until it becomes a mere marginal line at the anal angle.

Underside clear bright ochreous yellow: lower half of fore wing paling to primrose-yellow; a brown spot at the end of each cell, large on the fore wing; a suffused brownish marginal patch near hinder angle of fore wing: a brown patch on the costa at the apex of hind wing, and a discal (nearly submarginal) row of brown spots across both wings, one in each interspace, bent in on the costa of fore wing, the spots largest on the upper half of hind wing, but otherwise of fairly uniform size; a black marginal point on each vein in both wings.

♀. Differs from male above in its interior band limiting the subapical ochreous-red area, being broken in the middle, in the absence of the knob, and in the area being rather narrower.

The underside is dark chrome-yellow, paling to pale primrose on the lower half of the fore wing, and all the spots except the one at the end of the cell in the hind wing are large and of nearly uniform size.

Expanse of wings, ♂ $2\frac{6}{10}$, ♀ $2\frac{2}{10}$ to $2\frac{3}{10}$ inches.

Andaman Islands.

Allied to *I. andamana*, Moore; is much yellower, the ochreous-red patch in both sexes is deeper, and the black bands very much narrower, and below the male is well spotted on the hind wing, instead of being nearly immaculate, as in *I. andamana*.

8. *Appias olferna*, n. sp.

♂. Upperside white. Fore wing with the costal and outer marginal lines black; costal area with grey irrorations for two thirds of its length; base also slightly irrorated with grey; apical patch formed of thick brownish-black bars on the veins, as in *A. zelmira*, Cram., but shorter, paler, and more suffused, lessening in length hindwards and inwardly confluent to the second median branch; an inwardly pointed large spot on the first median branch and a very small one on the submedian vein, sometimes absent. Hind wing with a marginal row of small, faint, blackish-grey spots, one on each vein; in one specimen these spots are obsolete.

Underside: fore wing white; basal and costal area for two thirds of its length thickly irrorated with grey, and a few submarginal grey lunular marks; apical area and the entire surface of hind wing tinged with yellow: hind wing with a touch of ochre on the costa at the base; a thin sprinkling of grey irrorations on the subcostal vein and first branch, and another thin sprinkling of grey atoms across the wing, passing just inside the end of the cell and turning upwards towards the apex.

♀. Above and below very much the same as in that sex of *A. zelmira*, but altogether whiter, the discal white area running in on the median vein to the base of the fore wing; the submarginal yellow spots smaller and the marginal brown band of the hind wing narrower.

Expanse of wings, ♂ ♀ $1\frac{2}{10}$ to $1\frac{4}{10}$ inch.

Maldah, April and May 1886.

Allied to *A. zelmira*, Cram.; differs considerably in the male in the paler colour of the black markings above, in the absence of the large black marginal spots of the hind wing, and underneath in the absence of the black veins.

9. *Appias Irvinii*, n. sp.

♂. Upperside white: fore wing with a blackish costal line, some grey irrorations on the costal area along two thirds of its length and some at the base; a black apical patch covering nearly one third of the costa at the apex and narrowing down the outer margin to the second median branch, its interior margin irregular and curved into the patch at its centre, the veins in the patch white: a small marginal spot on the first median branch and two or three small indistinct marginal spots on the veins in the hind wing.

Underside: fore wing white, some costal and basal irrorations as above; apical space and the entire surface of hind wing tinged with yellow; a few grey irrorations crossing the end of the cell, otherwise both wings are without marks.

♀. Upperside white. Fore wing with a broad blackish longitudinal band from the base to the end of the cell, completely filling its upper two thirds, continued up to the black costal line in a suffused form, and attached to the black marginal border by a black band on the third median branch, this band filling one third of the costa at the apex, is broader than in the male; it also has white veins, its inner margin curves in a similar manner, but is more irregular, forms two teeth on the first and second median branches, and is continued to the hinder margin; base of wing broadly suffused with blackish-grey irrorations. Hind wing with the base and interno-median interspace irrorated slightly with grey; outer margin with large blackish spots on the veins down to the second median branch, more or less confluent.

Underside coloured as in the male; apical yellow area limited by a blackish irregular thin band or line; costal band and connecting band as on the upperside, the former uniformly coloured up to the costa. Hind wing with the transverse line of irrorations as in the male, but darker; costa at the base touched with ochre.

Expanse of wings, ♂ ♀ $2\frac{3}{10}$ inches.

Mandalay, Upper Burmah, May 1886.

Allied to *A. olferna*; the male differs above in the black apical patch of the fore wing, and below in having no markings except the few grey scales across the end of the cell of the hind wing; the female differs widely, having no marks on the hind wing above except the marginal spots, and underneath the markings are peculiar to itself.

There are examples of this species in the British Museum from Upper Tenasserim.

10. *Appias retexta*, n. sp.

♂. Upperside white. Fore wing with black costal line, below which it is slightly irrorated with grey for two thirds its length; apical band narrow, formed by blackish spots fining inwards on the veins, more or less confluent on the margin, and decreasing in size to the first median branch, from which a blackish marginal line runs down to the hinder angle. Hind wing with some small indistinct marginal spots running slightly up the veins, which are obsolete in some specimens.

Underside white, a few grey irrorations on the costa of fore wing for two thirds of its length; costal and outer marginal lines black; otherwise both wings are unmarked.

♀. Upperside white. Fore wing with the costal line black; a broad black longitudinal band from the base filling up the whole discoidal space with the exception of a thin streak above the median vein, and reaching up to the costa, joining the apical black band by a thin black band along the third median branch; a black suffusion below the cell, covering the base of both wings and running out in the interno-median area for half the length of the fore wing; apical black band extending for more than a third of the costa, its inner margin excavated on the lower radial vein, leaving a white square-shaped space between it and the discoidal band, then curving downwards and lessening in width, it reaches the hinder angle, and has three teeth running in on the first and second median branches and on the submedian vein. Hind wing with large black marginal spots on the veins, more or less confluent, paling to the anal angle in a greyish suffusion, and connected with a discal circular shade by blackish thin bands or lines along the veins; this shade is formed of pale blackish irrorations, and runs round the cell and below the median vein, and is suffused over all the lower part of the wing excepting the abdominal margin.

Underside white. Fore wing with the costa grey, discoidal band and connecting band pale; apical band indicated by pale bands on the veins; lower basal band also visible. Hind wing with a pale black, short, marginal band at the apex, the discal shade short and distinct, in the form of a transverse band; marginal spots and connecting vein-lines also present.

Expanse of wings, ♂ ♀ $2\frac{2}{10}$ to $2\frac{4}{10}$ inches.

Bombay and Poona, July to December, common.

Allied to *A. libythea*, Fabr., the type of which (a female) is in the Fabrician cabinet at the British Museum, and has been carefully examined by me. There are three distinct forms or species in this group; the males of all are somewhat similar to each other, but when put in rows can easily be distinguished; the females are quite distinct and constant in their characteristics. *A. retexta* is the dark form, marked much like the female of *A. zelmira*, Cram., but without any spots in the apical border above and without any yellow coloration below. *A. libythea*, Fabr., has the apical border narrower, as is also the discoidal band; there is no connecting band, no suffused band below the cell, and no marks on the hind wing except the large marginal spots, which are disconnected, and below there are no marks at all except the discoidal and apical bands on fore wing faintly showing through the wing, and a transverse medial shade running across the end of the cell in the hind wing; the third form, *A. ares*, Swinhoe (Proc. Zool. Soc. 1885, p. 138), is the whitest of all, the apical and discoidal bands on the fore wing are very narrow and pale, and the hind wing above and the whole surface of both wings below are unmarked.

I have a long series of all three species.

11. *Huphina liquida*, n. sp.

♂ ♀. Upperside white. Fore wing with the costal line black, accompanied by some grey irrorations on the basal half; base also slightly irrorated; apical patch black, covering more than one third of the costa, and fining down to the hinder margin, before reaching which it becomes attenuated; interior margin of the patch slightly curved into the patch, more or less diffuse, running in on the veins, and with a bent knob on the second median branch in the female. Hind wing with a pale narrow marginal band, inwardly diffuse, becoming gradually obsolete towards the anal angle.

Underside: fore wing white, a broad costal band and apical patch pale greenish brown smeared with yellow; a large subapical yellow patch near the costa. Hind wing greenish yellow; median vein and a large shadowy band greenish brown; this band crosses the wing, covering the apical and discal portions, and has in it some large spots of the ground-colour of the wing.

The female only differs from the male in having more rounded wings and in being paler below.

Expanse of wings, ♂ $2\frac{1}{10}$, ♀ $1\frac{9}{10}$ inch.

Mahableshwur, April and May 1887.

Allied to *H. remba*, Moore, but is uniformly smaller; differs above in its much smaller apical patch of fore wings, its nearly pure white hind wings, and in its paler and yellower coloration below, particularly so in the female; in *H. remba* the brown band fills up the whole subcostal interspace and more than one third of the cell, whereas in *H. liquida* it is altogether clear of the cell and is purely discal.

I have *H. remba* from the Nilgiri Hills, from Calicut, and from Kanara, whence the type came.

Hesperidæ.

12. *Baoris sikkima*, n. sp.

♂ ♀. Upperside dark vinous brown. Fore wing with three semidiaphanous minute spots before the apex, the centre one the innermost, the upper one the smallest; two larger spots at the end of the cell (absent in the female), the upper one the smaller: three spots in the disk, the largest in the first median interspace, square above and pointed outwardly below on the first median branch; the second outside the first, smaller, more or less square, in the second median interspace; the third minute and round, but generally larger than the subapical spots, outside the second and in the lower radial interspace,—the female has an additional spot in a line with the others in the interno-median interspace, with its lower side touching the submedian vein, and about the same size as the second discal spot; sometimes, but not always, there is a very minute spot immediately below the first discal spot. Hind wing without markings, the patch of velvety hairs on the hind wings of the male reddish at their base.

Underside slightly paler; spots on fore wing as above, the lowest discal spot in the female largely suffused, the outer half of the two lowest interspaces in the fore wing of the male pale and shining, the inner half in both sexes blackish, with a patch of brown raised scales in the centre of the submedian vein in the male.

Expanse of wings, ♂ ♀ $1\frac{8}{10}$ inch.

Sikkim, 1889.

Allied to *B. scopulifera*, Moore (Proc. Zool. Soc. 1883, p. 532); differs in both sexes in having three instead of two subapical spots, in having three instead of two discal spots in the male, which are differently shaped, and differs very materially in the female. This insect is included by Mr. de Nicéville as one of the varieties of *B. oceia*, Hewitson. The descriptions of the so-called variations of *B. oceia* by Wood-Mason and de Nicéville in Journ. As. Soc. Bengal, 1881, p. 258, are to me incomprehensible—*B. oceia*, Hew., is a Philippine insect. Hewitson's type, now in the British Museum, which I have carefully examined, is from the Philippines, and is not an Indian insect; above this type Hewitson appears to have put several Indian Hesperids which are of two if not three different species, and none of them correspond with the type. If any one will examine the type of *Nilasera amantes*, Hew., in the British Museum incorporated collection, with the insects Hewitson placed over that name in the Hewitsonian collection, also in the British Museum, he will understand in what manner Hewitson failed sometimes to recognize his own species. There are several other instances of a similar kind in the Hewitsonian collection. If Wood-Mason and de Nicéville's contention be correct that this insect is so very variable as they state, then it must stand as *B. scopulifera*, Moore, because it is not *B. oceia*, Hew.; but it appears to me that *B. scopulifera* as described by Moore, his *B. unicolor*, and the insect I have now described as *B. sikkima* are all good species of constant characteristics; they vary a little, but not more than Hesperids usually vary, and I can show a satisfactory series of all three species.

13. *Parnara astigmata*, n. sp.

♂. Upperside blackish brown. Fore wing with two semi-diaphanous, yellowish-white, confluent spots at the end of the cell; a large square spot in the first median interspace, a smaller spot outside in the interspace above, and two subapical minute spots; in one specimen a third still more minute spot near the costa. Hind wing without markings; cilia of both wings yellowish white, with black marks opposite the veins.

Underside slightly paler. Fore wing with the spots as above and with a row of submarginal, indistinct, small, pale yellowish spots, one in each interspace, down to the second median interspace. Hind wing with a whorl of seven minute white spots in the interspaces round the cell, commencing near the base, with two in the costal interspace, one behind the other; an indistinct submarginal row of faint whitish spots, ending with two diffuse, larger, confluent spots in the interno-median interspace; cilia of both wings as above.

Antennæ with the outer half of the club yellowish white; hook dark chrome-yellow.

Expanse of wings $1\frac{6}{10}$ to $1\frac{7}{10}$ inch.

Nilgiri Hills, western slopes, 2000 to 3000 feet; common.

A wonderful mimic of *Halpe cerata*, Hewitson. The absence of the discal oblique series of raised scales in the fore wing above (the sexual characteristic of the genus *Halpe*) at once distinguishes it from that genus; above it very nearly resembles *H. cerata*, but the discal whorl of spots on the hind wing is deficient; below the spots and markings are of a similar pattern, but are very minute.

14. *Suastus bipunctus*, n. sp.

♂ ♀. Upperside dark blackish brown. Fore wing with a small, lunular-shaped, semidiaphanous, whitish spot below end of cell in the first median interspace, and a smaller round spot outside in the interspace above. Hind wing without markings.

Underside paler, with the spots as above, and with markings and coloration as in *S. aditus*, Moore.

Hook of antennæ dark ochreous. The spots in the females are larger than in the males; in one or two specimens of both sexes there is a very minute subapical spot, but most of the males are without it, and some of them have only one small spot in the second median interspace, the other being obsolete.

Expanse of wings $1\frac{2}{10}$ to $1\frac{3}{10}$ inch.

Nilgiri Hills, western slopes, 2500 feet. September, common.

Allied to *S. aditus*, Moore; differs in the absence of the two prominent quadrate spots at the end of the cell of the fore wings above, in the blackness of the cilia, and in the very minute size of the spots.

15. *Teligonus lara*, n. sp.

Upperside dark reddish brown. Fore wings elongate, narrow, apex produced, pale brownish grey, outer border very oblique; three semihyaline spots, much as in *T. thrax*, Linn., but comparatively much smaller, nearly white, very faintly tinted with chrome-yellow. Hind wings without markings.

Underside as above, but paler.

Antennæ white for one third before the hooked tip.

Expanse of wings $2\frac{3}{10}$ inches.

Nicobar Islands.

Allied to *T. thrax*, Linn.; spots similarly placed, but of a different colour; the band on the antennæ white instead of yellow, and the apex of fore wing pale greyish instead of brown. The insect is altogether much smaller, the fore wing much produced, the outer margin being so very oblique as to leave the hinder margin very short, measuring a trifle over $\frac{6}{10}$ of an inch.

XLVII.—*New* Scarabæidæ *in the British Museum.* By Charles O. Waterhouse.

I have recently been rearranging and determining the Coleoptera of the family Scarabæidæ. I was unable to find the following species described.

Scarabæus Reichei.

Oblongus, sat depressus, niger; capite rugoso, postice medio lævi, antice acute sex-dentato; thorace elytris bene latiore, paulo convexo, fortiter crebre punctato, linea irregulari mediana maculisque quatuor ante basin lævibus, lateribus crenulatis nigro-ciliatis; elytris sat depressis, nigro-fuscis, opacis (sutura lævi), distincte striatis, striis subtiliter punctulatis, interstitiis sat convexis, subtilissime confertissime granulatis, punctis sat parvis subseriatim notatis, lateribus tricarinatis; metasterno piloso, medio canaliculato, punctato.

Long. 19 millim.

Hab. Cape of Good Hope.

This species has the general form and characters of *S. intricatus*, F., but is much larger. The thorax has the punctures similar to those in *S. intricatus*, but crowded together, leaving a smooth median line and four irregular smooth spots near the base. The elytra are dull, very densely and finely granular; each interstice has in its middle portion very minute shining dots, which are placed near together and give a more shining appearance to the middle of the interstice. The metasternum has an impressed line for its whole length; the punctures are distinct and not very widely separated.

Scarabæus Anderseni.

Niger, viridi-cyanescens, nitidus; capite acute sex-dentato; thorace lato, convexo, fortiter punctato; elytris fortiter striatis, striis fortiter punctatis, interstitiis sat convexis punctis irregularibus interruptis.
Long. 10 millim.

Hab. Lake Nyassa.

Very near *S. morbillosus*, Fabr., but slightly tinted with bluish green. The thorax is broad, convex, and shining, crenulated at the sides and with long recurved hairs near the hind angles; the punctures are rather large and deep, usually separated from each other by the diameter of a puncture, but more distant at the back part of the disk. The elytra have the striæ strongly impressed, each with a series of strong punctures, which are rather smaller than those on the thorax; the interstices are marked at irregular intervals with punctures similar to those in the striæ; these punctures in some places touch each other and form an impression which interrupts the interstice. The antennæ are yellow, except the basal joint. The metasternum is smooth and shining and has a deep longitudinal median impression. The metasternal process is much less prominent than in *S. morbillosus*, and more obtuse; its sloping sides are distinctly punctured. The anterior tibiæ have four equidistant teeth, the uppermost one only slightly smaller than the others.

Scarabæus Wilsoni.

Niger, sat opacus; capite rugoso, antice acute sex-dentato; thorace sericeo-opaco, punctis asperatis sat crebre asperso, linea mediana excepta; lateribus denticulatis, nigro-ciliatis; elytris piceo-tinctis, confertissime subtilissime granulatis, sicut sericeis, leviter striatis, striis punctis parvis haud approximatis notatis, interstitiis fere planis, evidenter sparse punctatis; tibiis anticis longe quadridentatis; posticis intus dense, extus longius nigro-ciliatis.
Long. 26 millim.

Hab. Persia (*J. Wilson, Esq.*).

This interesting species has the form and general characters of *S. sacer*, but has a quite different appearance on account of the silky sculpture and the longer and more dense hair on the legs; the elytra are a little narrower and the reflexed margin is narrower. The head has a slightly indicated transverse ridge, interrupted in the middle. The teeth in front and those on the anterior tibiæ are rather longer and more slender. The thorax has the surface extremely finely coriaceous or granular; studded with very distinct shining granules, the granules rather larger and distinctly more separated from each other, and, as is usually the case, they are almost absent in the middle of the base, where there are some distinct, but not very deep, punctures; small punctures may also be seen near the shining granules. The elytra have the interstices punctured; the punctures are distinct but not deep, irregular, generally separated from each other by about two diameters.

Sebasteos Poggei.

Convexus, niger, parum nitidus; capite crebre ruguloso, epistomio subtus dentibus duobus armato; thorace lato, convexo, crebre fortiter punctato, linea mediana lævi, angulis anticis acutis extrorsum directis; elytris basi angustatis, striatis, interstitiis convexis, punctis nonnullis subseriatim notatis; tibiis anticis longis, angustis, intus dentatis, ante apicem sinuatis, extus quadri-dentatis.
Long. 15 millim.

Hab. Congo.

Somewhat resembles *S. galenus*, but is rather larger and differs as follows:—Head relatively broader, with the posterior angles more rounded; epistome broadly triangularly emarginate, with the two middle teeth not so porrect; the surface longitudinally rugulose. Thorax very broad, much more strongly punctured, or, rather, the punctures are much larger, irregular, generally very near together; at the sides small tubercles take the place of the punctures. Elytra considerably narrowed at the base, and consequently the sides are more rounded; the interstices are convex, especially the third and fifth, each with a line of distinct punctures. The anterior tibiæ are longer, with the apical third distinctly sinuate on the inner side.

Gymnopleurus Thelwalli.

Rotundato-oblongus, bene convexus, fusco-æneus, supra surdus; capite antice medio emarginato, granulato; thorace coriaceo-opaco, nitide granulato, maculis novem paulo elevatis nitidis ornato, lateribus obtuse denticulatis, angulis posticis acutis, paulo productis; elytris brevibus, convexis, granulis minutis aspersis, haud striatis, vittis paulo elevatis, interruptis, nitidis instructis; lateribus pone humeros acute angulatis, ante apicem haud dilatatis, apice arcuatim rotundatis.

Long. 9 millim.

Hab. Lake Nyassa (*Thelwall*).

Nearly allied to *G. Kœnigii*, F., but shorter and more convex. The head is finely coriaceous and studded with small shining granules, which are slightly separated from each other; there is no smooth median line. The thorax is of nearly the same form as in *G. Kœnigii*, but the sides are more rounded in front and crenulate; the surface is coriaceous or finely granular, thickly studded with small shining granules, which are rather near together; there is a small median smooth spot on the disk, with three irregular shining spots on each side, and between these and the side (behind the middle) there is an oblique spot, somewhat interrupted in the middle; there is a small impression in the middle of the base. The elytra have an acute angular projection before the lateral sinuosity; the surface is dull and studded with minute shining granules, which are generally near together; each elytron has two very much interrupted, slightly raised, slightly shining stripes, and between the suture and the first stripe there is an elongate but ill-defined smooth spot. The metasternum is not produced anteriorly, but slopes down, and is studded with a few asperate punctures.

Gymnopleurus Bocandei.

Oblongus, convexus, æneo-fuscus, surdus, flavo-griseo-pilosus; capite granulato, antice fere octo-dentato; thorace antice oblique angustato, crebre granulato, maculis septem parum elevatis nitidis, fovea laterali profunda, basi foveis duabus distinctis, lateribus post medium paulo sinuatis, haud serrulatis, angulis posticis paulo productis, obtuse rotundatis; elytris subtilissime sericeo-granulatis, tenuiter sat crebre asperato-punctatis, leviter obtuse striatis, interstitiis alternis maculis obsoletis calvis ornatis; corpore subtus sat nitido, cuprascente.

Long. 12 millim.

Hab. Senegambia.

This species is closely allied to *G. maculosus*, McLeay, but is more convex, of a brassy brown colour, and much less distinctly spotted. The head has eight angulations in front, the middle pair more prominent; above there is on each side an oblique raised line. The thorax is formed as in *G. maculosus*, but is more convex and has the posterior angles more prominent; there is a small smooth spot in the middle and two others on each side of the disk, and another close to the lateral fovea. The elytra have the small asperate punctures distinct and moderately close together; the spots on the alternate interstices are very obscure.

Gymnopleurus signaticollis.

Obscure fusco-æneus, surdus, brevissime flavo-griseo-pilosus; thorace antice oblique angustato, crebre granulato, maculis circiter octo nitidis æneis ornato, basi bifoveolato, lateribus haud serrulatis, angulis posticis rotundatis; elytris subtilissime coriaceis, crebre subtiliter granulatis, striis vix impressis.
Long. 12 millim.

Hab. Nubia.

This species is very close to *G. maculosus*, McLeay, but is quite differently coloured and has no spots on the elytra. The head is rather closely punctured. It has four teeth in front (besides the obtuse angle of the lateral lobe), the outer ones obtuse. The thorax is obliquely narrowed in front, broadest before the hind angles, which are rounded and not so produced as in *G. maculosus*; the surface is dull, dotted with very small shining granules, which are rather close together; there are two very distinct foveæ at the base and the lateral fovea is also very distinct; there is a small, smooth, shining green spot in the middle and another between this and the base, and on each side of the disk are three very irregular shining spots. The elytra are rather flattened, with very obscure striæ, dull, dotted with minute shining granules, which are rather close together. The metasternum is declivous, rather closely punctured.

Gymnopleurus Reichei.

Fusco-niger, opacus; capite sat crebre granulato, antice triangulariter inciso; thorace ante medium oblique angustato, postice subparallelo, confertim subtiliter rugoso, antice granulis nitidis asperso, disco et basi medio impressione notatis; elytris coriaceis, obsolete striatis, interstitiis secundo et quarto parum convexis, granulis minutis aspersis; metasterno sat crebre punctato, medio paulo inflato.
Long. 11 millim.

Hab. Abyssinia.

This species is allied to *G. maculosus*, but has much the appearance of *G. mopsus*. The head as in *G. mopsus*, but a little narrower and with a more distinct angular emargination in front; the raised lines are the same; the granulation is a little more distinct. The thorax is more convex, more finely rugose, more distinctly angular in the middle of the sides, more parallel behind the middle; the surface is sprinkled with minute shining granules, as in *G. mopsus*, but they are smaller and only distinct at the front margin and front angles; there is a very shallow impression in the middle of the disk and another at the base, and on each side of the disk there are indications of similar impressions; near the front there are two very inconspicuous shining spots; the lateral fovea is well marked. The elytra are dull, with the second and fourth interstices very gently convex; the surface is sprinkled with minute shining granules, smaller and much less numerous than in *G. mopsus*. The anterior femora have a small tooth on the front, rather beyond the middle. The metasternum is more widely swollen in front than in *G. mopsus*.

Gymnopleurus Jacksoni.

Æruginosus, supra surdus; capite antice bidentato; thorace lato, antice arcuatim angustato, confertim subtiliter rugoso, angulis posticis perparum reflexis; elytris confertim subtiliter rugosis, stria suturali solum distincta; metasterno antice paulo tuberoso.

Long. 15 millim.

Hab. E. Africa, Masailand (*F. J. Jackson, Esq.*).

Dark green, dull. Head finely rugose; bidentate in front; the usual oblique ridges at the sides not extending far back. Thorax very broad, closely and rather finely but distinctly rugose, with a slight sinuosity behind the posterior angles, which are rectangular (but obtuse at the very apex) and slightly reflexed. The elytra at their widest part are scarcely so wide as the widest part of the thorax; the surface rugose as the thorax. The anterior femora with a small tooth at less than one third from the apex. Metasternum closely and finely rugose in front, with a distinct round swelling in the middle. Sides of the metasternum dotted with small tubercles. Pygidium closely and finely rugose.

This species is very near to *G. humanus*, McL., but is a little less finely rugose, has the posterior angles of the thorax less prominent and less acute; and the metasternum has the anterior swelling rounded, and not at all pointed.

Gymnopleurus Delagorguei.

Oblongo-ovatus, paulo convexus, opacus, æneo-fuscus, subtus æruginoso-niger; capite crebre granulato, antice quadri-dentato; thorace creberrime granuloso-rugoso, angulis posticis obtusis; elytris leviter striatis, creberrime granuloso-rugosis, sutura parum nitida; metasterno antice paulo obtuse tuberoso, granulato.

Long. 17 millim.

Hab. Port Natal.

Dull brassy brown. The head with four obtuse triangular teeth in front; the surface dotted with more shining granules; those in front are curved, slightly separated from each other; on the vertex they are closer, smaller, and more elongate; the usual lateral ridges are distinct, and curve inwards posteriorly. The thorax is evenly convex; the surface granular, the granules slightly shining, very distinct; between the granules the surface is very finely rugose; the lateral impression is small; the posterior angles obtuse, not produced; there are no basal impressions. The elytra are a trifle wider than the thorax; the striæ are distinct but dull; the surface is dotted with minute but distinct shining granules, which are very close together. The pygidium is rugose. The anterior femora have a small tooth just beyond the middle. The tibiæ are moderately broad, with three strong teeth. The metasternum in front is somewhat asperate, with a swelling in the middle which is inclined to be angular; the sides of the metasternum are strongly asperate.

This species has much the appearance of *G. mundus*, but has no basal fovea to the thorax, and the sculpture is quite different.

Gymnopleurus inconspicuus.

Oblongus, olivaceus, æruginoso tinctus, parum nitidus, subtus æruginosus, nitidus; capite granuloso et subtilissime rugoso, antice obtuse quadri-dentato; thorace convexo, ante medium oblique angustato, opaco, crebre granuloso, basi biimpresso, lateribus pone medium paulo sinuatis, angulis posticis oblique rotundatis, perparum reflexis; elytris thorace vix latioribus, sat crebre nitido-granulatis, leviter striatis; metasterno medio nitido, tenuiter parce punctato, antice angulato-tuberoso, opaco, subtiliter crebre granulato; pygidio obsolete punctulato.

Long. 17 millim.

Hab. N.W. India, Mhow (*Major Yerbury*).

The head is very finely rugose, with more shining granules scattered over the surface, the granules of unequal size, strongest on each side of the vertex, those at the front part of the epistome range themselves in twos and threes transversely. The thorax is evenly convex, dull, with very distinct depressed granules, which are close together on the disk (often touching each other), rather smaller and more separated at the sides; the posterior angles are slightly impressed and obliquely rounded. The elytra are dull, the granules very distinct and shining, but very small and very slightly raised, moderately close together; with a strong magnifying-glass minute asperate punctures may be seen between the granules. The anterior tibiæ are incurved beyond the middle. The anterior femora have a small tooth rather before the middle. The metasternum is vertical in front, the vertical part finely and closely granular.

This species is very close to *G. Dejeanii*, but is differently coloured, a trifle narrower, and the posterior angles of the thorax are more impressed and a little more prominent.

Gymnopleurus subtilis.

Oblongus, paulo convexus, niger, parum nitidus; capite subtiliter rugoso, antice granuloso, obtuse quadri-dentato; thorace creberrime subtiliter granuloso-rugoso, lateribus arcuatis, angulis posticis obtusis; elytris leviter striatis, subtilissime coriaceis, crebre subtiliter granulosis; metasterno medio fere lævi, nitido, antice convexo, crebre granuloso, fusco-fimbriato.

Long. 19 millim.

Hab. N. India (*Col. Buckley*).

The head is closely and rather finely rugose, more asperate in front. The middle pair of teeth in front separated by a comparatively narrow incision. The thorax is not very convex, a little more narrowed in front than behind; densely and finely granulose-rugose, with numerous small shallow punctures scattered over the surface, only visible in certain lights; the lateral fovea is round and not very deep; there are no basal impressions; the margins are narrowly and slightly reflexed, the posterior angles obtuse and not prominent laterally. The elytra are very finely coriaceous and finely granular, the granules rather close together, very small (but slightly unequal), shining. The upper margin of the basal segment of the abdomen is distinctly thickened. The metasternum is rounded in front (not tuberose in the middle), arched, granulose, and clothed with long brown hair.

This species is allied to *G. caffer*, Fähr.

Gymnopleurus diffinis.

Oblongus, sat convexus, sat nitidus, æneo-cupreus, pedibus nigrescentibus; capite confertim subtiliter rugoso, epistomio asperato, antice quadri-dentato; thorace subtiliter coriaceo-rugoso, sat crebre minute punctato, lateribus rotundatis, angulis posticis haud prominentibus; elytris sericeo-opacis, leviter striatis, creberrime subtiliter nitido-granulatis.

Long. 14 millim.

Hab. Senegambia.

The thorax is somewhat shining, more obliquely narrowed in front than behind, very obtusely angular at the sides, more finely sculptured than the head, very delicately but densely rugose, and finely punctured; the punctures are small but distinct, and separated from each other by about three diameters of a puncture, at the sides they are indistinct; the lateral fovea is small and round. There are no basal impressions. The elytra are less shining than the thorax, very finely coriaceous, with very closely-placed, minute, shining dots or granules; the striæ are fine, and in them some very fine punctures may be seen. The metasternum is shining, with an interrupted median impressed line, slightly curved down anteriorly, and then more obliquely declivous, the front part rather dull, rather closely asperate-punctate and pilose, with an indication of a small angular tuberosity in the middle. The anterior femora have a small tooth rather beyond the middle. ♀.

This species is allied to *G. hilaris*, Hope, but the thorax is more narrowed at the base, &c.

XLVIII.—*British Fossil Crinoids.* By F. A. Bather, M.A., F.G.S.

II. *The Classification of the Inadunata Fistulata* (continued from p. 334).

[Plate XV.]

Differential Characters.

C. *The Arms.*

We have now to consider the value of Arm-characters in classification. Here the main principles are so simple and so generally acknowledged that their discussion need not detain us long. They are as follows:—

The simplest form of arm consists of a series of ossicles continuing the line of the Radial; the joint-faces of the ossicles are parallel to one another, and there are no pinnules. This, it is fairly obvious, must also be the most primitive form of arm: examples are, *Hybocrinus*, *Hoplocrinus*, and *Baerocrinus* (Pl. XV. figs. 1*a*, *b*).

Nearly as simple would be an arm splitting in two, on the 2nd or 3rd costal as axillare, and of which each half should resemble the preceding type: such arms are not indeed found in any known Fistulata, but they represent a stage through which that group must have passed. What appears to have been the case is that this dichotomy once started was rapidly continued, so that the next stage presents us with arms dividing equally at fairly regular intervals: *Dendrocrinus*, *Homocrinus*, *Iocrinus*, *Merocrinus*, *Cyathocrinus*, and a few genera closely allied to these have arms of this type (Pl. XV. figs. 2, 3, 4). As every additional bifurcation is an advantage to the animal, it is reasonable to suppose that an arm with a large number of terminal branches is more advanced in development than one with few; some species of *Cyathocrinus* for instance have a far larger number of bifurcations than others.

The next stage shows one limb of each bifurcation after the first becoming smaller than the other; thus, instead of one regularly dichotomous arm, there arise two main arms with bifurcating branches given off alternately on either side. At first these branches attain quite or almost the length of the main arm, e. g. *Heterocrinus*, *Ohiocrinus*, and *Belemnocrinus* (Pl. XV. figs. 5, 6, 7, 20). The advantage of such an arrangement over simple dichotomy is not at once obvious, but it seems to be that the food-grooves are thus more evenly distributed over the area covered by the extended arms; further we may suppose the arms to be more easily wielded when there is a stout median ridge. At any rate further evolution takes place in this direction; the main arm becomes fringed with armlets which again bear small lateral branches, e. g. *Vasocrinus*, *Barycrinus*, and some *Botryocrini* (Pl. XV. figs. 9, 10). When finally the armlets become small, cease to branch, and are regularly placed on alternate sides of successive joints, they are called Pinnules; a species of *Botryocrinus* from the Wenlock Limestone is the earliest form known to have reached this stage, which is again exemplified in *Decadocrinus*, *Scytalecrinus*, *Graphiocrinus*, and other allied genera (Pl. XV. figs. 13, 14, 15).

This, however, is not the only way in which pinnulate arms have arisen; pinnules of course always originate in the same way, but their arrangement on the arm may be different. *Anomalocrinus* (Pl. XV. fig. 11) is enough to show that pinnules may be developed directly on a dichotomous arm, although it is so anomalous a form that it leads no further. But the pinnules of *Scaphiocrinus* and *Poteriocrinus* also appear to have arisen on dichotomous arms without interfering with the dichotomy (Pl. XV. fig. 12); how this may have happened is seen in a very beautiful specimen of *Cyathocrinus* in the British Museum in which the arms are very finely divided at the tips and so closely resemble pinnules that even Mr. Springer was deceived when he examined the specimen. Similar minute division of the arms is common in *Homocrinus* and may equally well have occurred in *Parisocrinus*; and it is with these genera rather than with *Cyathocrinus* that *Poteriocrinus* is in other respects allied. Pinnulate arms of this type may continue to increase in complexity by dichotomy, and then by giving off lateral branches just in the same way as simple arms; but such complexity does not appear till the Mesozoic Epoch.

The types of arm hitherto considered are uniserial, *i. e.* with the joint surfaces of the ossicles more or less parallel to one another. But in pinnulate arms, since every ossicle of the main arm is really an axillare with its two upper joint surfaces unequal in size, there arises a zigzag arrangement of the joint surfaces. This may be so intensified as to produce a biserial arrangement of arm-ossicles; thus in a given length of arm the number of pinnules is doubled, greatly to the advantage of the animal. This biserial arrangement is chiefly developed in the genera with the two main arms in each ray; the same physiological end is attained in a different manner by the genera with dichotomous arms.

The foregoing statement of facts will probably be accepted by all; from it the following consequences arise:—Neither the branching of the arms by itself, nor the development of pinnules by itself can be taken as characters indicative of divergence, for similar evolution may have taken place along many different lines. As regards arms, for instance, no one would associate *Ohiocrinus* with *Vasocrinus*, *Holocrinus* with *Scytalecrinus*, *Iocrinus* with *Homocrinus* or *Cyathocrinus*, or *Euspirocrinus* with *Oncocrinus* because these genera happen respectively to have very similar arm-structure. The unimportance of pinnules on the other hand is best exemplified by the genus *Botryocrinus*, for while the Swedish species have armlets and not pinnules, the common Dudley species has undoubted pinnules and its arm-arrangement in no way differs from that of *Decadocrinus*. In recent Crinoids pinnules differ from arms only by containing the fertile portions of the genital glands; but it is pretty obvious that in these older Crinoids without pinnules, the genital products must have been borne at the tips of all the arm-branches: hence the physiological difference need not even have been so great as the morphological. There is, however, one character, or rather combination of characters, which seems to be of rather greater importance, and that is the persistence of a simply bifurcate arm bearing first armlets and then pinnules, as opposed to the development of pinnules on a dichotomous arm. Between these two types no connecting-links are evident.

Arm-characters in general may, however, be used as a check on other methods of classification; they enable us to correct possible errors in phylogeny, for instance a pinnulate form cannot be the ancestor of one with simple arms. In this aspect their study proves of great importance.

D. *Modes of Union.*

The different varieties of suture and articulation by which the plates and ossicles of Crinoidea are held together will be found explained in the section on Terminology (p. 314, *antè*) under the words Syzygy, Close Suture, Loose Suture, and Muscular Articulation; repetition is therefore unnecessary.

On the variations of these structures in different genera Messrs. Wachsmuth and Springer have laid some stress (Rev. III. (189) Proc. 1886, p. 113), and have taken the greater differentiation of articulation in their family Poteriocrinidæ as "a good distinction" between them and their family Cyathocrinidæ. These differences are, however, rather of degree than of kind; loose suture and even articulation may take the place of a close suture whenever there is any need for greater movement; while on the other hand a sutural union may become syzygial when greater firmness is required. It would certainly not be philosophical to separate a genus because certain of its articulations were better developed than those of the other genera of its family. Undoubtedly, however, some amount of regular evolution is observable in this point; later forms, as a rule, combine firmness and free motion, while earlier forms are but slightly flexible.

A difference of union, correlated with a difference in arm-branching already pointed out, is worth notice. In dichotomous pinnulate arms the several axillaria are united to the succeeding plates by muscular articulation; in simply bifurcating pinnulate arms there is only one axillare that can be so united. Thus the more cumbrous dichotomous arms have their powers of movement equalized with those of the simply bifurcating arms (*Decadocrinus*, *Scytalecrinus*). But in some later genera of the simply bifurcate type the balance is again brought over by the articulation of several of the proximal arm-plates (*Graphiocrinus*, *Erisocrinus*, *Eupachycrinus*), such as never takes place in dichotomous pinnulate arms.

Principles of Classification.

The chief variations in the structure of the Fistulata considered, it only remains to be seen how we can best frame a classification that shall show the true relationships of the various genera. For it is this which has come to be the object of Systematic Biology. Morphology nowadays devotes itself to tracing the past history and true kinship of the forms of life; most especially is this the province of those divisions of the science known as Embryology and Palæontology. But whereas Embryology deciphers its history in the palimpsest of an individual, Palæontology reads records that are both consecutive and distinct. The first step then is to gather from the successive fossils the actual history of the lines of life. Two forms might be very similar, but if one came from the Cambrian and the other from the Trias, we should hesitate to place them near one another before having worked out the actual descent; indeed we should not be surprised to find them belonging to quite different Families. This, however, might equally be the case with two forms not only similar but contemporaneous. How many a group once thought to be self-centred and clearly circumscribed has been proved to have a polygenetic origin!

But Palæontology, while thus indicating the solution of one problem of classification, puts before us another of no less difficulty. The Zoologist, or—to better name him—the Neontologist, deals with forms co-existing at a single epoch; the Palæontologist has to deal with forms that come and go through many an earth-period. A line of life not only gives off branches, but itself varies, so that the later descendants differ greatly from their earlier ancestors. The problem is to express this latter variation in Classification. A new term is required: a *Series* must be distinguished from a *Division*; the former is a difference in degree, the latter in kind. I have thought it necessary to draw attention to these well-known principles, for any Classification must depend on its methods no less than on the facts to be represented by it, and every one's method does not seem to be the same. It is in fact the fashion with a certain school of naturalists to sneer at phylogeny. But surely to learn the history of the races of living beings, and the laws governing that history, is the object of all our labours. On this alone can a true and final Classification be based, and to express this in convenient form is the Classifier's only purpose.

Geological History.

Let us then turn to the history of the Fistulate Crinoids. The outline of this history must be sought for in the time-succession of the various genera. This is expressed in the accompanying Table (I.) of Geological Distribution. The American rock series has been taken as the most convenient; for the horizons of the various fossils are more distinct and have been more carefully noted by American geologists, and Crinoids appear to be found in America at more horizons than in Europe. The horizons or localities of extra-American genera are noted in brackets: W. L. = Wenlock Limestone and M. L. = Mountain Limestone. To those who have read carefully the earlier part of this paper, a mere inspection of this table will suggest the various lines of descent. So far as positive evidence goes there is nothing here to conflict with the history of evolution in various structures as sketched out in preceding sections. There are of course gaps in the chain of evidence; but these were to be expected. Their slight importance is brought out more clearly by the plan here adopted of printing the name of a genus only opposite those strata in which it has actually been found. *Calceocrinus* for instance, which is known in the Niagara and Wenlock Limestones and which persists with slight modifications to the Keokuk, must have been living in the Waverley, Chemung, and Helderberg eras. Till it has been discovered we need not hope to find forms intermediate between, say, *Botryocrinus* and *Vasocrinus*. Moreover the sudden appearance in the Trenton Limestone of no less than 9 genera, all very distinct from the 3 rare genera found in earlier rocks, is an obvious indication of a series of Cambrian ancestors as yet known only by a few undecipherable fragments: it is as unnecessary, as it would be absurd, to derive all these from *Hybocrinus* and *Hoplocrinus*.

Among the forms known from the Trenton and earlier rocks are both Monocyclic and Dicyclic genera. I have already given reasons to show that Monocyclica may have been derived from Dicyclica (p. 318 *antè*); but the table shows that certain Monocyclic forms are actually the earliest known, viz. *Hybocrinus*, *Hoplocrinus*, and *Baerocrinus*. Now these forms differ so markedly, both in the arm-structure and in the arrangement of the anal plates, from the other early Monocyclica that they must be regarded as quite a separate family. It is impossible to derive any of the other genera immediately from them. This family—the Hybocrinidæ of v. Zittel, as emended by Wachsmuth and Springer—may therefore be set on one side, and the course thus far cleared.

The remaining Monocyclica of the Trenton are *Ectenocrinus*, *Heterocrinus*, *Iocrinus*, and *Castocrinus*. Of these the last is obviously already much modified in the direction of *Proclivocrinus* and *Calceocrinus*; if the line along which the *f the I*

.....	Encrinus.	Dadocr.	Trias.
thiocr.	Erisocr.	Ceriocr.	Coal-measures.
.....	......	......	Kaskaskia.
.....	......	......	St. Louis.
.....	......	......	Warsaw.
cr.	Stemmatocr.	....	Keokuk.
cr.	Erisocr.	......	Upper Burlington.
cr.	Erisocr.	......	Lower Burlington.
.....	......	......	Waverley.
.....	......	......	Chemung.
cr. acr. lian).	......	......	Hamilton.
acr. r-Dev	......	......	Upper Helderberg.
.....	......	......	Oriskany.
.....	......	......	Lower Helderberg.
cr. ocr. L.).	......	......	Niagara.
.....	......	......	Clinton.
oc.	......	......	Hudson River.
oc.	......	......	Utica.
oc.	......	......	Trenton.
.....	......	......	Black River.
.....	......	......	Chazy.

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Table I., to show the Geological Distribution of the Fistulate Crinoids.

Trias																	Holocr.										Encrinus.	Dadocr.	Trias.
Coal-measures													Hydreionocr.	Cyathocr.	Lecythiocr.							Graphiocr.		Eupachycr.		Agassizocr.	Erisocr.	Ceriocr.	Coal-measures.
Kaskaskia									Zeacr.	Scaphiocr.	Woodocr.		Hydreionocr.	Cyathocr.						Scytalocr.	Decadocr.			Eupachycr.	Cromyocr.	Agassizocr.			Kaskaskia.
St. Louis										Scaphiocr.		Cœliocr.								Scytalocr.	Decadocr.								St. Louis.
Warsaw					Catillocr. (?)					Scaphiocr.	Woodocr.							Barycr.											Warsaw.
Keokuk			Calceocr.		Catillocr.				Parisocr.	Zeacr.	Scaphiocr.	Woodocr.			Cyathocr.				Barycr.	Vasocr.	Scytalocr.	Decadocr.	Graphiocr.		Eupachycr.	Tribrachiocr. (Australia).		Stemmatocr.		Keokuk.
Upper Burlington			Calceocr.		Catillocr.				Parisocr.	Poteriocr.	Scaphiocr.	Woodocr.	Cœliocr.	Hydreionocr. (M. L.).	Cyathocr.		Hypocr. (M. L., Timor).	Belemnocr.	Barycr.		Atelestocr.	Decadocr.	Graphiocr.	Bursacr.	Phialocr. (Russia).			Erisocr.		Upper Burlington.
Lower Burlington			Calceocr.						Parisocr.	Poteriocr.	Scaphiocr.	Woodocr.	Cœliocr.		Cyathocr.			Belemnocr.	Barycr.	Vasocr.	Atelestocr.	Decadocr.	Graphiocr.	Bursacr.				Erisocr.		Lower Burlington.
Waverley										Scaphiocr.	Woodocr.			Cyathocr.								Decadocr.	Graphiocr.							Waverley.
Chemung									Poteriocr.					Cyathocr.								Decadocr.								Chemung.
Hamilton			Calceocr.	Mycocr. (Eifelian).				Homocr.	Parisocr.	Poteriocr. (Eifelian).	Scaphiocr.		Lecythocr. (Eifelian).	Arachnocr.		Codiacr. (Eifelian).	Achradocr. (Eifelian).			Vasocr.		Decadocr.								Hamilton.
Upper Helderberg	Edriocr.													Arachnocr.	Cyathocr.	Codiacr. (Unter-Devon.)'														Upper Helderberg.
Oriskany	Edriocr.							Homocr.																						Oriskany.
Lower Helderberg	Edriocr.							Homocr.																						Lower Helderberg.
Niagara			Calceocr.	Proclivocr.	Catillocr.*	Herpetocr.	Thenarocr. (W. L.).	Homocr.	Dendrocr.	Euspirocr. (Gothland).	Ampheristocr.		Streptocr. (Gothland).	Arachnocr. (W. L.).	Cyathocr.	Gissocr. (W. L.).	Oncocr. (W. L.).		Sicyocr. (Gothland).	Botryocr. (W. L.).										Niagara.
Clinton										Closterocr.																				Clinton.
Hudson River	Anomalocr.	Ectenocr.	Heterocr.	Iocr., Ohiocr.				Carabocr.	Dendrocr.																					Hudson River.
Utica			Heterocr.			Merocr.			Dendrocr.																					Utica.
Trenton	Hybocr.	Ectenocr.	Heterocr.	Iocr.	Castocr.	Merocr.	Ottawacr.	Carabocr.	Dendrocr.	Euspirocr.																				Trenton.
Black River	Baerocr. (Brandschiefer). Hoplocr. (Vaginaten-Kalk).																													Black River.
Chazy	Hybocr.																													Chazy.

* Dr. Ringueberg tells me of this in a letter dated 5th March, 1890.

development of these genera has proceeded be prolonged *backwards* instead of forwards, we arrive at an ancestral image not unlike *Ectenocrinus*, *Heterocrinus*, or *Iocrinus*. We therefore conclude that these latter forms approach more nearly to the common ancestor. It remains to be seen which of the three is the most ancestral. In the first place *Iocrinus* has a simpler structure so far as the radials proper are concerned; and that in this case the simplicity is archaic I have already tried to show (p. 327, end of first paragraph). Secondly as regards the anal plates I have argued that *Iocrinus* represents a more primitive condition (top of p. 330). Thirdly the arms are simply dichotomous and not at all specialized into main arm and armlets. These arguments should be enough; but to my mind the existence of an exactly similar and contemporaneous form among the Dicyclica—viz. *Merocrinus*—proves that the two were descended from an ancestor possessing their common characters, and probably with a Dicyclic base. This ancestor then, if its existence be granted, was likewise the progenitor of *Ectenocrinus* and *Heterocrinus*, and, among the Dicyclica, of *Ottawacrinus* and probably *Carabocrinus*, and possibly of *Dendrocrinus* and *Euspirocrinus*.

The Monocyclic base is of course enough to separate *Ectenocrinus*, *Iocrinus*, &c. from the Dicyclic genera, and at their subsequent history we shall now do well to glance. Whether *Heterocrinus* or *Ectenocrinus* be the older is hard to say; *Heterocrinus* probably, as the brachianal is in a slightly more primitive position; the arms also are simpler in that the armlets are not so reduced in size, and the syzygial union of alternate joints characteristic of *Ectenocrinus* is not here developed. Be this as it may, *Ohiocrinus* is, both in time and arm-development, a natural descendant of *Heterocrinus*. *Anomalocrinus* is a peculiar offshoot from the same stock. Further than this it is impossible to trace the history of this family. *Edriocrinus*, *Belemnocrinus*, and *Holocrinus*, though Monocyclic, had certainly a different origin; *Edriocrinus*, however, is so extremely specialized in other respects that one cannot perceive its true affinities.

Mycocrinus and *Catillocrinus* appear to be connected in the structure of the dorsal cup with *Calceocrinus*; but the drooping on the stem, which seems to have been the main factor in inducing the structure of *Calceocrinus*, does not operate here. The resemblance may be merely homoplastic; if anything more, we must suppose that structures originally selected as conducing to one special object, were on a sudden diverted to another quite distinct. The peculiar arm-arrangement may have arisen from the modified lateral arms of *Calceocrinus* along lines similar to those followed in the evolution of *Crotalocrinus.* The whole problem, however, is one that, in the absence of more complete knowledge, admits of much speculation but of no satisfactory solution.

To pass to the Trenton Dicyclica—similar reasons cause me to regard *Merocrinus* as the most ancestral of the 5 genera. From *Merocrinus*, *Ottawacrinus* differs but little, and the two were doubtless derived from a common ancestor of not much earlier date. With this same ancestor *Carabocrinus*, though an anomalous form, may have been closely connected. But *Dendrocrinus* was probably derived more directly from *Ottawacrinus*, which, except in the development of a radianal, it closely resembles. *Euspirocrinus* again shows, so far as the arrangement of the anal area is concerned, a slight advance on *Dendrocrinus*, from an immediate ancestor of which genus it was probably descended. The arms of these genera resemble one another in their simple dichotomy, and afford no evidence either way. One thing is plain—*Merocrinus*, *Ottawacrinus*, *Dendrocrinus*, and *Euspirocrinus* are all closely connected, and are all primitive. Their exact relationships are of less importance.

Proceeding to the Niagara and Wenlock Limestones we find, chiefly in the Old World, a great influx of new forms. *Thenarocrinus* may be connected with *Carabocrinus*, but its exact significance will be more fittingly discussed in a later paper. *Homocrinus* very obviously carries on the line of *Dendrocrinus*. *Euspirocrinus* of Gothland and *Closterocrinus* of the Clinton group are direct descendants of the Trenton *Euspirocrinus obconicus*, while *Ampheristocrinus* is a very close relation.

The four genera *Streptocrinus*, *Arachnocrinus*, *Cyathocrinus*, and *Gissocrinus* resemble one another in the presence of a large brachianal in line with the radials, and in the absence of a radianal. In this latter respect they differ from all their contemporaries; and here a moot point crops up:—has the radianal become atrophied in *Cyathocrinus*, or was it never developed? Messrs. Wachsmuth and Springer adopt the former, I incline to the latter view. If my reading of *Ottawacrinus* (Pl. XIV. fig. 12) be correct, it is very easy to derive *Cyathocrinus* and its allied genera from that genus without supposing such a waste of force as the sudden growth and more sudden disappearance of a radianal. The American authors were evidently driven to their view by their belief that the radianal was a primitive element of the dorsal cup. They will perhaps point out that *Botryocrinus* and *Sicyocrinus* actually represent the intermediate stages in the atrophy of the radianal; this, however, is disproved by the arms, for while those of *Cyathocrinus* &c. are simply dichotomous, the more specialized armlets are already developed in *Sicyocrinus* and *Botryocrinus*.

Clearly then the Dicyclica of Niagara and Wenlock age must be divided into three groups: one with brachianal, large radianal, and tendency of tube-plates to sink into dorsal cup; a second with large brachianal only; and a third with large brachianal and with small radianal. The first group has rather slender, long, dichotomous arms; the second has short, rather stout, dichotomous arms; the third has stouter arms, as a rule with armlets.

Following the fortunes of the first group, *Homocrinus* leads us through the Lower Devonian to the Eifel-Kalk of Europe and the Hamilton group of America. Here occur *Parisocrinus*, *Poteriocrinus*, and *Scaphiocrinus*, all closely resembling one another in the anal area, and in this point also not far removed from *Homocrinus*. The main difference is observable in the arms; those of *Homocrinus* and *Parisocrinus* are simple and dichotomous, while those of *Poteriocrinus* and *Scaphiocrinus* are already pinnulate. There is here one of those gaps which a better knowledge of American Devonian Crinoids would probably fill. From *Scaphiocrinus* through *Woodocrinus* to *Cœliocrinus* and *Hydreionocrinus* the stages are gradual and easily traced.

It is convenient next to take the third group mentioned above, viz. the *Botryocrinus* group. Here again is a great gap: at the same time there can be little doubt that both *Vasocrinus* and *Barycrinus* are direct descendants of *Botryocrinus*; with them *Atelestocrinus* is closely connected. *Decadocrinus*, which comes in with *Vasocrinus*, appears to me to be also descended from *Botryocrinus*, although it is rather further removed from it than is *Vasocrinus*. With *Decadocrinus* are closely connected the rather later forms *Graphiocrinus* and *Scytalecrinus*. *Graphiocrinus*, however, presents that modification in the anal area (Pl. XIV. fig. 36) which through *Bursacrinus*, *Phialocrinus*, and *Synyphocrinus* leads on to *Erisocrinus*, *Ceriocrinus*, and *Stemmatocrinus*, and culminates in the Triassic *Dadocrinus* and *Encrinus*. A different modification of the *Decadocrinus* type is seen in *Eupachycrinus*, with which *Tribrachiocrinus* is probably to be connected. *Cromyocrinus* is a direct offshoot from *Eupachycrinus* and to it in turn *Agassizocrinus* is closely allied.

These relationships are so obvious, and in fact so generally acknowledged, that I have not judged it necessary to enter into details. But there is one point in which I differ very materially from previous writers; that is the separation of these forms which I have just described as descended from *Botryocrinus*. Other authors place them close beside *Poteriocrinus* (s. str.) and *Scaphiocrinus*. But the dichotomous many-branched arms of these two genera and their allies could hardly have sprung from the bifurcate, heavily pinnulate arms of *Decadocrinus*, *Graphiocrinus*, and *Scytalecrinus*, without leaving some traces of the process; these latter closely resemble the arms of *Vasocrinus* and of some species of *Botryocrinus*. This seems a sufficient reason for separating the two groups; I have already alluded to differences of articulation connected therewith; besides this there is a general similarity of what is called "habit" in the members of each group, and there is certainly nothing to oppose their alliance in this manner.

To return to the *Cyathocrinus* group; that genus itself persists unchanged to the Coal-measures. In *Codiacrinus* the brachianal seems to have been again raised above the level of the radials, and has not yet been observed. *Achradocrinus* shows an atrophy of the brachianal, and a diminution of the arms, characters which are still more pronounced in *Hypocrinus*. *Lecythocrinus* is probably a descendant of *Gissocrinus*, and *Lecythiocrinus* of *Codiacrinus*.

The Dorsal Cup of *Belemnocrinus*, except for its monocyclic base, resembles that of *Cyathocrinus*; the arms show a tendency to the development of armlets, but are not a great advance on those of *Cyathocrinus*: on the whole I incline to the belief that this genus is descended from *Cyathocrinus*, but that intermediate stages have not yet been found. *Holocrinus* is an advance on *Belemnocrinus* both as regards atrophy of the brachianal and the conversion of armlets into stout pinnules.

In each of these lines there is a gradual development of articulation; this, however, can merely serve to confirm the general evolution, and it varies so much according to the needs of individual genera that under no circumstances could any great argument be based on it.

Classification.

The Genealogy of the Fistulata may be summed up in the accompanying table (Table II.). It is of course needless in the present year of grace to point out the differences between a scheme such as this, which shows general relationships, and

TREE OF FISTULATE CRINOIDS.

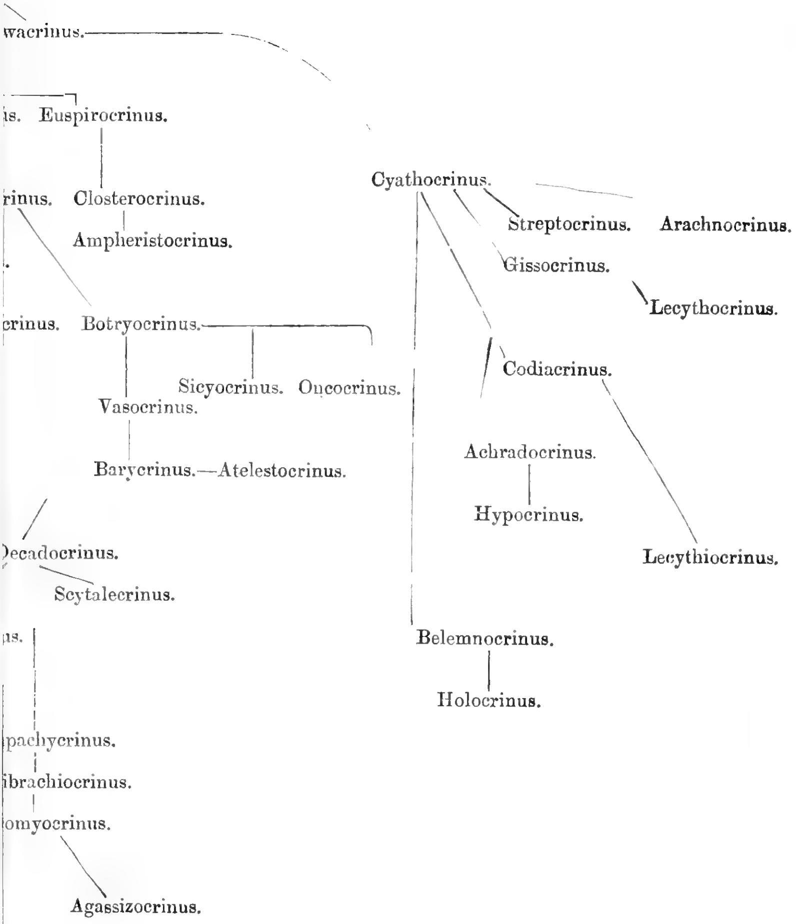
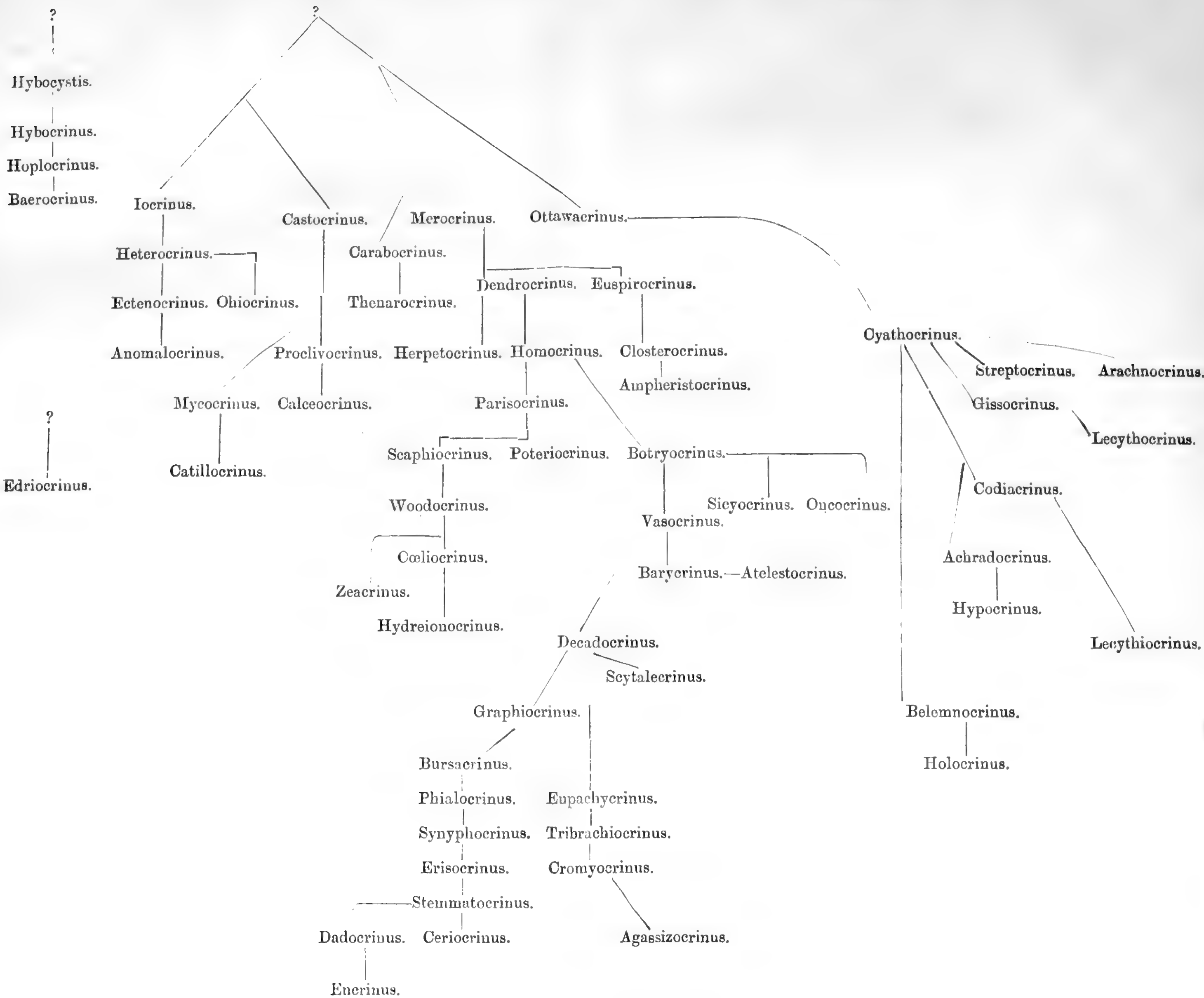


Table II.—GENEALOGICAL TREE OF FISTULATE CRINOIDS.



a tree that follows out the descent of individuals. To represent this in convenient classificatory form is the final problem.

First there is a group which one feels almost inclined to remove entirely from the Fistulata, viz. the HYBOCRINIDÆ; the ventral sac of *Hybocrinus* and *Hybocystis*, in which genera alone it has been observed, is very small, and its truly fistulate nature doubtful*.

There are next two main groups, one of which includes the families HETEROCRINIDÆ (to which I add *Anomalocrinus*), CALCEOCRINIDÆ, and CATILLOCRINIDÆ. So far the families are very nearly the same as those maintained by Messrs. Wachsmuth and Springer.

The second group, which comprises all the Dicyclic and two Monocyclic forms, must be again split up, and here a rather different arrangement from that of previous writers seems inevitable.

First comes a Division characterized by brachianal, large radianal, and usually some other anal plates in the dorsal cup, and by dichotomous arms. This can again be divided into three; on one side a Family including *Carabocrinus* and *Thenarocrinus*, but of this I am doubtful; on the other a Family of *Euspirocrinus* and its descendants, and in the middle a Family continuing the main line through *Dendrocrinus*; this is conveniently split into two Series marking the development of pinnules; Series 1. may be called **Dendrocrinites**, Series 2. **Scaphiocrinites**. The Family itself, which will include *Merocrinus* and *Ottawacrinus*, may be called DENDROCRINIDÆ.

The next great Family starts from *Botryocrinus*, and this again must be split into series; the **Botryocrinites** will include all in which the radianal is rudimentary, and pinnules as a rule not yet evolved from armlets; the **Scytalecrinites** will include *Decadocrinus* and *Scytalecrinus*, both of which are elongate (σκυτάλη), have three anal plates in dorsal cup, and have pinnules; the **Graphiocrinites** will include genera in which the radianal is lost but in which the brachianal remains in the limits of the dorsal cup; the **Erisocrinites** of Wachsmuth and Springer may remain, or may be included with the **Encrinites**, as comprising genera in which no anal plate remains in the dorsal cup of the adult; the **Cromyocrinites** will include the rounded forms in which the three anal plates are retained in the cup. In allusion to the ten arms borne by all genera of the Family, the name DECADOCRINIDÆ may be fitly applied to it.

* W. & S. Rev. III. (199, 200) Proc. 1886, p. 123.

The last great family consists of descendants of *Cyathocrinus*, and for it may be best retained the name CYATHOCRINIDÆ, though at the risk of some confusion with the previous applications of the term; but these applications have been so numerous that one more can hardly make the confusion worse confounded than it already is. It will be advisable to separate this family into **Cyathocrinites**, **Codiacrinites**, **Achradocrinites**, and **Belemnocrinites**.

Possibly, however, the Family BELEMNOCRINIDÆ, as its origin is so uncertain, may be allowed to stand as Wachsmuth and Springer defined it (Rev. III. (193) Proc. 1886, p. 117).

The Classification then may be tabulated as follows:—

FISTULATA.

?Fam. HYBOCRINIDÆ. *Hybocrinus*, *Hoplocrinus*, *Baerocrinus.*

GROUP A.

Fam. 1. HETEROCRINIDÆ. *Iocrinus*, *Heterocrinus*, *Ectenocrinus*, *Ohiocrinus*, *Anomalocrinus.*

Fam. 2. CALCEOCRINIDÆ. *Castocrinus*, *Proclivocrinus*, *Calceocrinus.*

Fam. 3. CATILLOCRINIDÆ. *Mycocrinus*, *Catillocrinus.*

GROUP B.

Fam. 1. DENDROCRINIDÆ.

Series 1. **Dendrocrinites.** *Merocrinus*, *Ottawacrinus*, *Dendrocrinus*, *Herpetocrinus* (?), *Homocrinus*, *Parisocrinus.*

Series 2. **Scaphiocrinites.** *Poteriocrinus*, *Scaphiocrinus*, *Woodocrinus*, *Zeacrinus*, *Cœliocrinus*, *Hydreionocrinus.*

Fam. 2. ?CARABOCRINIDÆ. *Carabocrinus*, *Thenarocrinus.*

Fam. 3. EUSPIROCRINIDÆ. *Euspirocrinus*, *Closterocrinus*, *Ampheristocrinus.*

Fam. 4. DECADOCRINIDÆ.

Series 1. **Botryocrinites.** *Botryocrinus*, *Sicyocrinus*, *Oncocrinus*, *Vasocrinus*, *Barycrinus*, *Atelestocrinus.*

Series 2. **Scytalecrinites.** *Decadocrinus*, *Scytalecrinus.*

Series 3. **Graphiocrinites.** *Graphiocrinus*, *Phialocrinus*, *Ceriocrinus* (*Bursacrinus*, *Synyphocrinus*)?.

Series 4.—(*a*). **Erisocrinites.** *Erisocrinus*, *Stemmatocrinus.*

(*b*). **Encrinites.** *Dadocrinus*, *Encrinus.*

Series 5. **Cromyocrinites.** *Eupachycrinus*, *Tribrachiocrinus*, *Cromyocrinus*, *Agassizocrinus.*

Fam. 5. Cyathocrinidæ.

Series 1. **Cyathocrinites.** *Cyathocrinus*, *Streptocrinus*, *Arachnocrinus*, *Gissocrinus*, *Lecythocrinus.*

Series 2. **Codiacrinites.** *Codiacrinus*, *Lecythiocrinus.*

Series 3. **Achradocrinites.** *Achradocrinus*, *Hypocrinus.*

Fam. 6. Belemnocrinidæ. *Belemnocrinus*, *Holocrinus.*

Incertæ sedis—*Edriocrinus.*

It seems unnecessary to indicate the diagnostic characters of these families and series more clearly than has been already done. The more *natural* a classification is, the more difficult must be any attempt at definition: as knowledge grows, delimitations vanish. Not that this classification is either natural or complete; of its imperfections in those directions no one can be more sensible than myself. The facts, indeed, on which the argument has been based have been verified as far as possible; the labour of collecting them, which would otherwise have been too great, has been lightened by the previous work of Messrs. Wachsmuth and Springer, to whom all students of palæozoic crinoids owe a debt of gratitude. That I differ from these authors is due partly to difference in the interpretation of the facts, partly to a difference of principle. The principles that govern the above classification, though not yet universally accepted, are steadily gaining ground among biologists. It is in the interpretation of the facts that the real difficulty lies, and here I am as likely as not to be wrong. Increased knowledge alone can solve our problems. The proposed classification should be regarded as a scaffolding necessary for the erection of that more solid structure to which it must one day give place.

EXPLANATION OF PLATE XV.

(Illustrating chief types of Arm-structure in Fistulate Crinoids.)

While the figures of this Plate are necessarily diagrammatic, they have been constructed either from actual specimens or from the best published drawings obtainable. Their order is merely intended to facilitate comparison and follows no scheme of classification. It is not possible to indicate in such a Plate the various degrees of articulation, but in figures 7 & 20 syzygies are represented by dotted lines. In each figure the radial is drawn in whole or in part. In the following notes the specific name is inserted when that particular species has served as copy for the diagram; other species of the genus have of course the same general structure. In the case of a genus not actually figured, the number indicates the type to which it approximates in arm-structure.

Achradocrinus—arms unknown.

Agassizocrinus—15; long, stoutish; ossicles short, cuneate; pinnules strong.

Ampheristocrinus—one brachial only known, quadrangular and very small.

Anomalocrinus—11; figure based on description by W. & S. Rev. III. (212) Proc. 1886, p. 136.

Arachnocrinus—3; heavy, scarcely diminishing towards tips; ossicles short, quadrangular, but axillaries longer.

Atelestocrinus—10; armlets from every 2nd ossicle, on alternate sides, extend to tips of arms.

Baerocrinus Ungerni—1 *a*; after Grewingk, from P. H. Carpenter, Quart. Journ. Geol. Soc. xxxviii. pl. xi. fig. 1.

Barycrinus—10; arms sometimes branch again on 3rd or 4th distichal, but never in anterior ray, and only in one arm to a ray; in *B. tumidus* (?) the antero-lateral rays have only one main arm apiece.

Belemnocrinus typus—20; see W. & S. Rev. III. 1885, pl. v. fig. 10.

Botryocrinus ramossissimus—9; after Angelin, *op. cit.* pl. xx. fig. 8.

Botryocrinus sp. nondescr.—13; from specimens from Dudley.

Bursacrinus—arms branch, and are in contact laterally; distichals wide, flat, slightly cuneate; palmars less than half the width. W. & S. consider this so close to *Graphiocrinus* that they have made it a subgenus thereof; otherwise its place would seem to be with the Scaphiocrinites, near *Woodocrinus*, from which it differs in the more advanced condition of the anal area. Without seeing specimens I do not like to venture on the alteration.

Calceocrinus—pinnules not developed; lateral arms dichotomize in a peculiar manner, out of the ordinary line of evolution.

Carabocrinus—3; arms short compared with size of calyx.

Castocrinus—arms irregularly dichotomous, non-pinnulate.

Catillocrinus—arms simple, not branched, many rise from a single radial as shown in Pl. XIV. fig. 29.

Ceriocrinus—15.

Closterocrinus—arms obscure, see Hall, Pal. N. Y. vol. ii. p. 179, pl. xli A. figs. 2 *a–f*.

Codiacrinus—3; see Follmann, "Unterdevonische Crinoiden," Verh. d. nat. Ver. preuss. Rheinl. xliv. pl. iii. fig. 1, 1887.

Cœliocrinus—" in its arm-structure leans decidedly towards *Woodocrinus*," W. & S. Rev. III. (245) Proc. 1886, p. 169.
Cromyocrinus—15; brachials short, at first quadrangular, then cuneate and in some species interlocking.
Cyathocrinus—3.
Dadocrinus Kunischi—17; after Kunisch, Zeitschr. d. deutsch. geol. Ges. xxxv. pl. viii. 1883. In the separation of *Dadocrinus* and *Holocrinus* from *Encrinus*, I have followed W. & S.; for a conspectus of the literature see H. Eck, " Bemerkungen über einige Encrinus-Arten," Zeitschr. d. deutsch. geol. Ges. xxxix. 540, 1887.
Decadocrinus—14.
Dendrocrinus—4.
Ectenocrinus—7.
Edriocrinus—arms broad at base; in *E. sacculus* costals 10 or more, distichals 3 or 4, palmars 3 or 4, all very short and wide; nothing known of pinnules; Hall, Palæont. N.Y. iii. pl. lxxxvii. fig. 10.
Encrinus—18.
Erisocrinus—15; costals abut laterally; brachials uniserial, transversely oblong.
Eupachycrinus—as in *Cromyocrinus*; arms from 1 to 3 in a ray.
Euspirocrinus—3; ossicles stout and wide.
Gissocrinus—3.
Graphiocrinus—15.
Herpetocrinus—4.
Heterocrinus exilis—5 *a*; *H. juvenis*—5 *b*; both after Hall, Rep. Geol. Surv. Ohio, Palæont. i. pl. i. figs. 12 and 3 *a*.
Holocrinus Beyrichi—19; after Picard, Zeitschr. d. deutsch. geol. Ges. xxxv. pl. ix. figs. 4 and 1.
Homocrinus—4.
Hoplocrinus—1 *b*.
Hybocrinus conicus—1 *b*; after E. Billings; in Canadian Org. Rem. decade iv. pl. ii. fig. 2 *b*, the long arms are all shown.
Hydreionocrinus—16; throw off branches towards inner side of ray, meet laterally; earlier ossicles cuneate and tend to interlock; pinnules short.
Hypocrinus—arms unknown, evidently very small.
Iocrinus—2.
Lecythiocrinus—arms unknown.
Lecythocrinus—3; see Schultze, " Echinod. Eifler Kalkes," Denkschr. k. Akad. Wiss. xxvi. pl. iv. fig. 1, Wien, 1867.
Merocrinus—2; see Walcott, State Mus. 35th Regent's Rep. pl. xvii. figs. 5 and 6, 1883.
Mycocrinus—arms unknown, probably as in *Catillocrinus*.
Ohiocrinus oehanus—6; after Ulrich, Journ. Cincinn. Soc. Nat. Hist. v. pl. v. fig. 9.
Oncocrinus—simple, dichotomous, with broad ossicles. *Cyathocrinites scrobiculatus*, Hisinger (Leth. Suec. Suppl. Secund. p. 6, tab. xxxix. fig. 4, *a*, *b*, *c*: Stockholm, 1840), appears to be of the same genus as the specimens I was about to describe as *Oncocrinus bucephalus*. *C. scrobiculatus*, however, has been referred by Angelin (Icon. Crinoid. pp. 13 and 14) to his genus *Pycnosaccus*. This genus has been placed by W. & S. in the Ichthyocrinidæ as a subgenus of *Lecanocrinus* (Rev. I. (41) Proc. 1879, p. 264), and, so far as *P. nodulosus*, Ang., is concerned, they are no doubt right. *P. costatus*, Ang., was by both Angelin and W. & S. regarded as belonging more probably to the Cyathocrinidæ (*auctorum*); this also seems correct. But *P. costatus* was in

Angelin's opinion allied to *C. scrobiculatus*, and I believe that the latter also should be removed from *Pycnosaccus*; only the evidence of Angelin's pl. xv. fig. 11 could lead one to retain it in that genus, and this figure has a most artificial appearance. Until, therefore, an examination of the type specimens is possible, I shall, for convenience' sake, continue to speak of *Oncocrinus*.

Ottawacrinus—(4?); beyond the 6 quadrangular costals nothing is yet known.

Parisocrinus radiatus—8; after de Koninck and Le Hon, Recherches sur les Crin. carb. Belgique, pl. i. fig. 12 *b*.

Phialocrinus—15.

Philocrinus—16.

Poteriocrinus—12.

Proclivocrinus—as *Calceocrinus*, *q. v.*

Scaphiocrinus Swallovi—12; in this sp. the ossicles interlock towards tips of arms; after Whitfield, Amer. Mus. Nat. Hist. N. Y. Bull. i. December 1881, *sub Poteriocr. Jesupi.* For clearness' sake the pinnules are only shown along one set of branches.

Scytalecrinus—15.

Sicyocrinus—9.

Sphærocrinus—3.

Stemmatocrinus—18. See Trautschold, "Mon. Kalkbr. Mjatschkowa," Mém. Soc. Imp. Nat. Moscou, xiv. pl. xiv. fig. 12 (1879).

Streptocrinus—3, but not much known of arms.

Synyphocrinus—*vide sub Bursacrinus.*

Tribrachiocrinus—arms unknown except so far as shown in Pl. XIV. fig. 35.

Vasocrinus—10; 3 costals; arms and armlets less robust.

Woodocrinus macrodactylus—16; after de Koninck, Mém. Acad. Roy. Belgique, xxviii. pl. viii. fig. 1 *c* (1854). For clearness' sake the pinnules are only shown along one branch.

Zeacrinus—16; dichotomize towards inner side of ray; ossicles short, their width diminishes by $\frac{1}{2}$ in successive orders; arms meet laterally, *cf. Bursacrinus.*

XLIX.—*On some new and imperfectly-defined Species of Jurassic, Cretaceous, and Tertiary Nautili contained in the British Museum (Natural History).* By Arthur H. Foord, F.G.S., and G. C. Crick, Assoc.R.S.M., F.G.S., Assistant in the Geological Department, British Museum.

In the last number of this Magazine we described and redefined some species of Jurassic Nautili in the British Museum. In this article we complete for the present our work upon the Jurassic and take up the Cretaceous and Tertiary species. Since the former paper was published some Jurassic forms have been added, enabling us to describe a new species from the Lower Oolite.

Appended is a list (pp. 390 and 391) of all the Cretaceous and Tertiary Nautili now in the Museum, together with the new Jurassic species. The species are arranged in two columns; the first contains the new species and also those requiring emendation, the second includes only well-recognized species; to each of the latter, however, the reference to the original description is attached.

It will be observed that some of the species described below are placed in the subgenus *Hercoglossa*, Conrad *. The following is Meek's † emended description of this subgenus:—"Shell more or less discoid, with umbilicus closed or small, and periphery usually rather narrowly rounded ‡; volutions deeply embracing, surface nearly smooth, or with lines of growth; septa deflected backwards in crossing each side, so as to form a deep, usually angular, lateral lobe." Type *Nautilus orbiculatus*, Tuomey §. Trias to Eocene.

Nautilus Parkinsoni, Edwards ||, is cited by Meek as belonging also to *Hercoglossa*. Of this species only two examples are known to us, both from the London Clay—the one figured by Parkinson ¶ and also by Edwards, now in the "Sowerby Collection," British Museum, the other from Colchester. Both specimens are remarkably large; Parkinson's consists merely of the casts of three chambers, to which a portion of the inner whorls, badly preserved, is attached; the largest chamber is 8 inches in height and 6 inches in width. Owing to the form of the sutures some doubt originally existed as to whether this specimen should not be placed in *Aturia*. Although the siphuncle is cylindrical, as in *Nautilus*, the sutures suggested its being the adult of *Aturia*. Unfortunately the inner whorls are so much crushed that the form of the siphuncle in the young shell cannot be ascertained. The specimen from Colchester, which measures 11 inches in diameter, shows, however, that the siphuncle is cylindrical not only in the adult, but even where the diameter of the shell does not exceed $2\frac{1}{4}$ inches. We feel justified therefore in concluding with Meek that *Nautilus Parkinsoni* belongs to the

* Amer. Journ. of Conchology, 1866, vol. ii. no. 2, p. 101.

† United States Geol. Surv. Terr. 1876, vol. ix. p. 491.

‡ Sometimes flattened, as in *Nautilus* (*Hercoglossa*) *franconicus*, Oppel, or even sulcated, as in *N.* (*H.*) *Picteti*, Oppel. For other species of *Hercoglossa* see "Die Cephalopoden der Stramberger Schichten," in Oppel and Zittel's 'Palæontologische Mittheilungen,' 1868, Band i. Abth. ii. Atlas, pls. ii., iii., iv. On referring to the 'Catalogue of Scientific Works' published by E. Koch, Stuttgart (1880–1886), we find that this part of the Palæont. Mitth. is erroneously marked both on the cover and titlepage "Zweiter Band, Erste Abtheilung," whereas it should be "Erster Band, Zweite Abtheilung."

§ Proceed. Acad. Nat. Sci. Philadelphia, 1854, p. 167.

|| Mon. Eocene Mollusca (Pal. Soc.), 1849, pt. i. p. 49, pl. vii.

¶ 'Organic Remains,' 1811, vol. iii. pl. vii. fig. 15.

Jurassic.

1. *Nautilus lineolatus*, sp. nov.
2. —— (*Hercoglossa*) *aganiticus*, Schlotheim.
3. —— (——) *franconicus*, Oppel.
4. —— (——) *portlandicus*, sp. nov.

Cretaceous.

5. —— *radiatus*, J. Sowerby.
6. —— *neocomiensis*, d'Orbigny.
7. —— *hunstantonensis*, sp. nov.
8. —— *triangularis*, Montfort.
9. —— *libanoticus*, sp. nov.
10. —— *Bayfieldi*, sp. nov.
11. —— (*Hercoglossa*) *danicus*, Schlotheim.

Nautilus undulatus, J. Sowerby, Min. Conch. vol. ii. p. 87 (1813), pl. xl.
—— *plicatus*, Fitton, Trans. Geol. Soc. vol. iv. pt. ii. p. 129 (woodcut) (1835).
—— *farringdonensis*, Sharpe, Quart. Journ. Geol. Soc. vol. x. p. 181 (1854), pl. vi. figs. 1 *a*, 1 *b*.
—— *Saxbii*, Morris, Ann. & Mag. Nat. Hist. ser. 2, vol. i. p. 106 (woodcut) (1848).
—— *pseudoelegans*, d'Orbigny, Pal. Franç., Terr. Crét. tom. i. p. 70 (1847), pls. viii. & ix.
—— *albensis*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. ii. p. 122 (1850).
—— *Clementinus*, d'Orbigny, Pal. Franç., Terr. Crét. vol. i. p. 77 (1840), pl. xiii. *bis*.
—— *Bouchardianus*, d'Orbigny, Pal. Franç., Terr. Crét. vol. i. p. 75 (1840), pl. xiii.
—— *Montmollini*, Pictet & Campiche, Pal. Suisse, sér. ii. p. 147 (1859), pl. xviii. figs. 4–6.
—— *Fittoni*, Sharpe, Foss. Mollusca Chalk, Mon. Pal. Soc. p. 17 (1853), pl. vi. fig. 4.
—— *Largilliertianus*, d'Orbigny, Pal. Franç., Terr. Crét. vol. i. p. 86 (1840), pl. xviii.
—— *Sowerbyanus*, d'Orbigny, Pal. Franç., Terr. Crét. vol. i. p. 83 (1840), pl. xvi.
—— *Fleuriausianus*, d'Orbigny, Pal. Franç., Terr. Crét. vol. i. p. 82 (1840), pl. xv.
—— *expansus*, J. de C. Sowerby, Min. Conch. vol. v. p. 83 (1824), pl. cccclviii. fig. 1.
—— *Deslongchampsianus*, d'Orbigny, Pal. Franç. Terr. Crét. vol. i. p. 90 (1840), pl. xx.
—— *elegans*, J. Sowerby, Min. Conch. vol. ii. p. 33 (1816), pl. cxvi.
—— *sublævigatus*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. ii. p. 189 (1850).
—— *quadrilineatus*, Favre, Descr. des Moll. Foss. de la Craie des environs de Lemberg en Galicie, p. 10 (1869), pl. iii. figs. 4 *a*, *b*.
—— *Reussi*, Fritsch, Cephalopoden der böhm. Kreideformation, p. 25 (1872), Taf. xii. figs. 4, 5.
—— *Dekayi*, Morton, Synopsis of the Organic Remains of the Cretaceous Group of the United States, p. 33 (1834), pl. viii. fig. 4.
—— *d'Orbignyanus*, Forbes, in Darwin's Geological Observations, pt. iii., Appendix, p. 265 (1846), pl. v. figs. 1 *a*, 1 *b*.
—— *Huxleyanus*, Blanford, Mem. Geol. Surv. India, Pal. Indica, p. 19 (1861), pl. vii. figs. 3, 4, pl. viii. figs. 1–3, pl. ix. figs. 1–4.

	—— *sphæricus*, Forbes, Trans. Geol. Soc. ser. ii. vol. vii. p. 98, woodcut (1846).
	—— (*Hercoglossa*) *trichinopolitensis*, Blanford, Mem. Geol. Surv. India, Pal. Indica, p. 37 (1861), pl. xxiii., pl. xxiv. figs. 1, 2.

TERTIARY.

12. *Nautilus* (*Hercoglossa*) *Cassinianus*, sp. nov.	—— *centralis*, J. Sowerby, Min. Conch. vol. i. p. 11 (1812), pl. i. (left-hand figure).
	—— *imperialis*, J. Sowerby, Min. Conch. vol. i. p. 9 (1812), pl. i. (upper and right-hand figures).
	—— *regalis*, J. de C. Sowerby, Min. Conch. vol. iv. p. 77 (1822), pl. ccclv.
	—— *Sowerbyi*, Wetherell, Phil. Mag. and Journ. vol. ix. p. 466 (1836), pl. vi.
	—— *urbanus*, J. de C. Sowerby, Min. Conch. vol. vii. p. 36 (1843), pl. dcxxviii.
	—— *macrocephalus* *, Schafhäutl, Süd-Bayerns Leth. Geogn. p. 214 (1863), pls. lvii., lviii.
	—— *ellipticus* *, Schafhäutl, Süd-Bayerns Leth. Geogn.
	—— *Labechei*, d'Archiac, Descr. des Anim. Foss. du groupe Nummulitique de l'Inde, livr. ii. p. 338 (1854), pl. xxxiv. figs. 13, 13 *a*, 13 *b*.
	—— *Forbesi*, d'Archiac, Descr. des Anim. Foss. du groupe Nummulitique de l'Inde, livr. ii. p. 338 (1854), pl. xxxiv. figs. 12, 12 *a*.
	—— *Deluci*, d'Archiac, Descr. des Anim. Foss. du groupe Nummulitique de l'Inde, livr. ii. p. 337 (1854), pl. xxxv. figs. 2, 2 *a*.
	—— sp.†, Miocene ?, near Geelong, Victoria (Australia).
	—— sp.†, Kirrind, Persia. See paper by W. K. Loftus, "On the Geology of Portions of the Turko-Persian Frontier," in Quart. Journ. Geol. Soc. vol. xi. p. 247 (1855).
	—— sp.†, Miocene, Malta. See paper by Lieut. Spratt, R.N., "On the Geology of the Maltese Islands," in Quart. Journ. Geol. Soc. vol. iv. pt. ii. p. 231 (1843).
	—— (*Hercoglossa*) *Parkinsoni*, Edwards, Eocene Mollusca, Mon. Pal. Soc. p. 49 (1849), pl. vii.

* The specimens from Kressenberg (Bavaria) referred to these two species are casts in a coarsely granular matrix, in which only the bare outline of the shell is preserved, without any other specific characters. In such circumstances their identity with Schafhäutl's species must be considered doubtful, and we may add that many of that author's species are, owing to their condition of preservation, very unsatisfactory.

† These are too imperfect for specific identification.

subgenus *Hercoglossa*, and not to *Aturia*. It may here be added that Conrad distinctly states in his description of *Hercoglossa* * that the siphuncle is not funnel-shaped [as in *Aturia*], but tubular. He includes in *Hercoglossa* the *Aturia Mathewsoni* of Gabb †, though doubtfully, because Gabb did not describe the character or position of the siphuncle in his species, merely stating "siphuncle large."

It is open to question whether *Grypoceras*, Hyatt ‡, should not be merged in *Hercoglossa*; we are inclined to the opinion that it should. Thus the type species of the former (*Nautilus mesodiscus*, Hauer §) is distinguished, according to Hyatt, from that of the latter (*N. danicus*, Schloth.) by the presence of a "V-shaped" ventral lobe in the sutures and by a flattening of the periphery "at some stage of growth." Now in some species the ventral lobe, as, *e. g.*, in the type, is perfectly distinct, but in others, as, for instance, *N. strambergensis*, Oppel ‖, it is so slightly indicated as to approach those species, such as *N. Oppeli*, Zittel ¶, in which there is no such lobe. In other species, again, the presence of the lobe is due, in part at least, to the sulcation of the periphery.

The flattening of the periphery mentioned by Hyatt as also one of the characters of *Grypoceras* is not always accompanied by "V-shaped ventral lobes," *Nautilus Picteti*, Oppel, having a flattened and sulcated periphery, but no ventral lobe. The distinction therefore between *Grypoceras* and *Hercoglossa* is very difficult to maintain.

We include also in *Hercoglossa* the genus *Enclimatoceras* of Hyatt **, type *E. Ulrichi*, White ††.

Professor Dr. K. A. von Zittel ‡‡ retains the name *Aganides*, Montfort, for *Nautilus franconicus*, Oppel, &c.; but if the type specimen of Montfort's genus came from Namur, as stated by Montfort and afterwards by Sonnini §§, there is a strong probability that it was a Goniatite, the rocks in that

* Amer. Journ. of Conchology, 1866, vol. ii. no. 2, p. 101.

† Geol. Surv. of California, Palæont. 1864, vol. i. p. 59.

‡ Proceed. Boston Soc. Nat. Hist. 1883, vol. xxii. p. 269.

§ 'Die Cephalopoden des Salzkammergutes,' 1846, p. 36, tab. x. figs. 4–6. See also Mojsisovics, 'Das Gebirge um Hallstatt,' 1873, p. 21, Taf. viii. fig. 1.

‖ 'Die Petrefactenkunde,' 1820, p. 83.

¶ "Die Cephalopoden der Stramberger Schichten," in Oppel and Zittel's 'Palæontologische Mittheilungen,' 1868, Band i. Abth. ii. p. 42, tab. ii. figs. 8–11.

** Proceed. Boston Soc. Nat. Hist. 1883, vol. xxii. p. 270.

†† Bull. United States Geol. Surv. 1884, vol. i. p. 17, pls. vii., viii., ix.

‡‡ Handbuch der Palæontology, Band ii. p. 383 (1884).

§§ Hist. Nat. des Mollusques (Montfort's ed. of Sonnini's 'Suite à Buffon'), tom. iv. 1799 (An x.), p. 253, pl. xlviii. fig. 1.

neighbourhood being of Carboniferous age. It is true that the siphuncle is represented in Sonnini's figure as nearly central, but this might have been a mistake on the part of the artist. It would at any rate be impossible to settle this question without a reference to the original specimen, and in the meanwhile it would not be advisable to adopt Montfort's name *Aganides* so long as there is any uncertainty about the type specimen *.

JURASSIC.

1. *Nautilus lineolatus*, sp. nov.

Sp. char. Shell thick, somewhat inflated on the sides, with a broad and flattened periphery; greatest breadth of the whorls at about the middle of the sides; aperture wider than high, presenting a distinctly subquadrate section. Umbilicus very small and deep, with rounded border. Septa moderately distant; sutures rather concave on the sides of the shell and forming a very slight sinus on the periphery. Siphuncle not seen. Test thick, ornamented with subregular lines of growth.

A large example from Vetney Cross, Dorsetshire, measures 6 inches in diameter and 4 inches in its greatest breadth.

Remarks. This species is closely allied to *Nautilus clausus*, d'Orbigny, but it is distinguished by its less rapid rate of increase, by its open umbilicus, and on the whole by its more compressed form. The body-chamber of a young example (no. 36952) exhibits traces of the anterior border of the impression of the shell-muscle.

We have not thought it necessary to figure this species, on account of its great similarity to *N. clausus.*

A small specimen from the Upper Lias of Fontaine-Étoupe-Four probably belongs to this species.

Horizon. Inferior Oolite (England); Upper Lias (France).

Locality. Yeovil, Somersetshire (no. 36952); Vetney Cross, Dorsetshire; Fontaine-Étoupe-Four (Calvados), France.

2. *Nautilus* (*Hercoglossa*) *aganiticus*, Schlotheim.

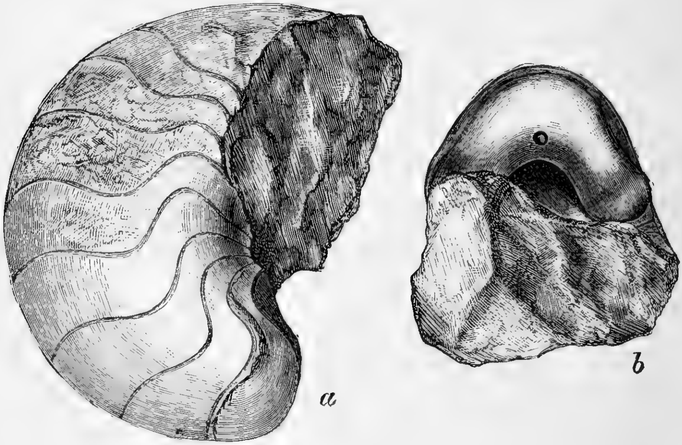
1820. *Nautilites aganiticus*, Schlotheim, Die Petrefactenkunde, p. 83.
1858. *Nautilus aganiticus*, Oppel, Die Juraformation Englands, Frankreichs und des südwestl. Deutschlands, p. 686.
1868. *Nautilus aganiticus*, Zittel, "Die Cephalopoden der Stramberger Schichten," in Oppel and Zittel's 'Palæontologische Mittheilungen,' Band i. Abth. ii. p. 43.

Sp. char. Shell somewhat inflated, slightly compressed on the sides, rather narrowly rounded on the periphery. Umbili-

* See remarks on the name *Aganides* by Meek (too long for insertion here), United States Geol. Surv. Terr. vol. ix. 1876, p. 494.

cus very small or perhaps closed. Septa wide apart, being 9 lines distant from each other where the height of the whorl is 2 inches. Sutures strongly arched forward after leaving

Fig. 1.



Nautilus (*Hercoglossa*) *aganiticus*.—*a*, lateral view of an imperfect specimen, showing the deeply lobed sutures; *b*, view of the septum which faces the letter *a* in the other figure, showing the position of the siphuncle. Drawn from a specimen in the British Museum (no. C. 3173). A little more than one half natural size.

the umbilicus, then sweeping backward in a larger curve, and again forward towards the periphery, which they cross without forming any sinus. Siphuncle situated a little below the centre.

Remarks. This species was long confounded with another from a higher horizon (the Tithonian), afterwards designated by Oppel *franconicus* *. The present species is now restricted to a form found in the Eisenoolith of Villecomte, in Lothringen (Lorraine) †. *N. aganiticus* is easily distinguished from *N. franconicus* by its much more inflated form, rounded periphery, somewhat less flexuous sutures, and the position of its siphuncle. In its general form, especially in the rounding of the periphery, this species bears a much closer resemblance to *Nautilus* (*Hercoglossa*) *portlandicus*, which, however, differs in the form of its sutures. It has perhaps also some relationship with *N. Forbesi*, d'Archiac, and *N. Deluci*,

* Oppel, "Die Tithonische Etage," Zeitschr. der deutsch. geol. Gesell. Band xvii. 1865, p. 546.

† Zittel, "Die Cephalopoden der Stramberger Schichten," in Oppel and Zittel's 'Palæontologische Mittheilungen,' Band i. Abth. ii. 1868, p. 43.

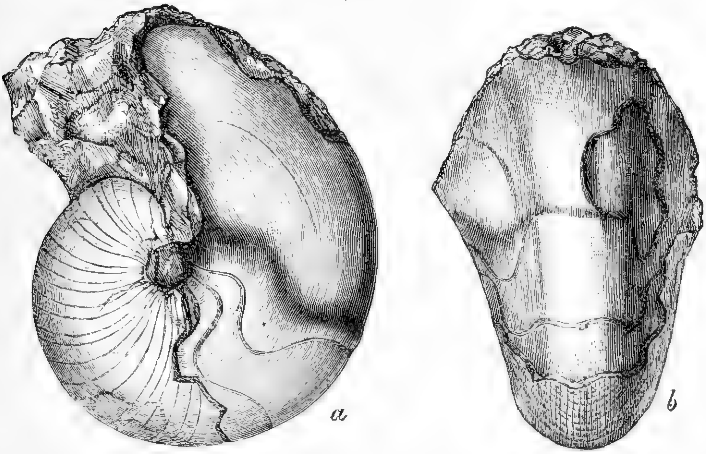
d'Arch.*, from the Eocene of Sindh (India), with both of which it agrees in the form of its sutures and the situation of its siphuncle; it is, however, a more inflated shell and has a rounder periphery than either of the Indian species.

Horizon. Inferior Oolite (Middle Brown Jura).

Locality. Villecomte, Lothringen.

3. *Nautilus* (*Hercoglossa*) *franconicus*, Oppel.

Fig. 2.



Nautilus (*Hercoglossa*) *franconicus*.—*a*, lateral view, showing two of the septa and a peculiar ridge at the base of the body-chamber; the curved line upon the cast of the latter is the anterior boundary of the impression of the shell-muscle; the test which covers the greater portion of the septate part of the shell is covered with fine lines of growth; they are a little too distinct in the engraving. *b*, peripheral view, showing the flattening of the sides and periphery. Drawn from a specimen in the British Museum (no. C. 3109). Nearly two thirds natural size.

1832. *Nautilus aganiticus*?, Bronn, in Leonhard and Bronn's Jahrbuch für Mineralogie, &c., p. 70.
1837. *Nautilus aganiticus*, von Buch, Ueber den Jura in Deutschland, Akad. der Wissensch. p. 119.
1849. *Nautilus aganiticus*, Quenstedt, Die Cephalopoden, p. 58, tab. ii. fig. 6 (not of Schlotheim).
1865. *Nautilus franconicus*, Oppel, Die Tithonische Etage, Zeitschr. der deutsch. geol. Gesell. Band xvii. p. 546.
? 1865. *Nautilus strambergensis*, Oppel, *ibid.*
? 1868. *Nautilus strambergensis*, Zittel, "Die Cephalopoden der Stramberger Schichten," in Oppel and Zittel's 'Palæontologische Mittheilungen,' Band i. Abth. ii. p. 42, Atlas, tab. ii. figs. 8–11.

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* 'Description des Animaux Fossiles du Groupe Nummulitique de l'Inde,' 1854, livr. ii. p. 337, (*N. Deluci*) pl. xxxv. figs. 2, 2 *a*; (*N. Forbesi*) pl. xxxiv. figs. 12, 12 *a*.

1870. *Nautilus aganiticus*, F. Roemer, Geologie von Oberschlesien, p. 252, Taf. xxiv. fig. 6.
1871. *Nautilus* cf. *strambergensis*, Herbich, Verh. u. Mitth. des naturwiss. Vereines zu Herrmanstadt.
1873. *Nautilus franconicus*, Neumayr, Die Fauna der Schichten mit *Aspidoceras acanthicum*, Abhandl. der k.-k. geol. Reichsanst. Band v. Heft 6, p. 156.
1875. *Nautilus franconicus*, von Ammon, Die Jura-Ablagerungen zwischen Regensburg und Passau, p. 163, tab. i. fig. 1.
1875. *Nautilus franconicus*, Favre, Descr. des Foss. du Terr. Jurass. de la Montagne des Voirons (Savoie), Mém. Soc. Pal. Suisse, vol. ii. p. 16, pl. i. figs. 6 *a*, 6 *b*.
1876. *Nautilus franconicus*, de Loriol, Mon. Pal.des Couches de la zone à *Ammonites tenuilobatus*, Mém. Soc. Pal. Suisse, vol. iii. pt. i. p. 13.
? 1877. *Nautilus aganiticus*, Blake and Hudleston, On the Coralline Rocks of England, Quart. Journ. Geol. Soc. vol. xxxiii. p. 400.
? 1878. *Nautilus aganiticus*, Hudleston, The Yorkshire Oolites, Proc. Geol. Assoc. vol. v. no 8, p. 482.
1878. *Nautilus franconicus*, Herbich, Das Széklerland mit Berücksichtigung der angrenzenden Landestheile, Mittheil. aus dem Jahrb. der kön. ungar. geol. Anstalt, Band v. Heft 2, p. 139, Taf. i. fig. 3.
1881. *Nautilus franconicus*, Schlosser, Die Fauna des Kelheimer Diceras-Kalkes, Abth. i. p. 61, Palæontographica, Band xxviii.

Sp. char. Shell much compressed laterally, flattened upon the periphery; the latter broad, with (in the cast) rounded borders. The greatest width of the whorls is in the umbilical region. The umbilicus is very small. The septa are moderately distant, the sutures very strongly bent, first forwards in a narrow lobe on leaving the umbilicus, then backwards in a broader one, then sweeping forward again and making a conspicuous sinus on the periphery. The siphuncle is situated considerably above the centre.

Remarks. Though Oppel, Zittel, and Neumayr unite in regarding *Nautilus strambergensis* as a distinct species from the present one, the resemblance between the two is very striking. The only difference between them is in the form of the sutures, which make a wider (backwardly directed) lobe on the sides of the shell in *N. franconicus* than they do in *N. strambergensis*, and this distinction is expressed in the figures of the latter given by Zittel (*loc. cit.*), which otherwise agree perfectly with specimens of *N. franconicus* with which we have compared them. The name *franconicus* was originally conferred by Oppel * upon a specimen from the Lithographic Slate of Solenhofen.

* "Die Tithonische Etage," Zeitschr. der deutsch. geol. Gesell. Band xvii. p. 546. The "Tithonian" is a special group of the Upper (White) Jura, including the period embraced between the Oxfordian and Portlandian series. See Oppel's 'Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands,' 1858; also Zittel's "Die Cephalopoden der Stramberger Schichten," Palæont. Mittheil. Band i. Abth. ii., 1868.

The locality of the specimen figured is unknown, but it agrees in all essential points with the German specimens in the Collection, and adds to our knowledge of the species the characters of the body-chamber and of the test. The latter is smooth, being ornamented only with delicate lines of growth. The last two septa are exposed by the removal of the test. A heavy ridge is developed near the base of the body-chamber, its indented outline corresponding roughly with that of the last suture. Part of the anterior boundary of the shell-muscle is seen on the cast of the body-chamber (see fig. 2). The aperture is deeply emarginate.

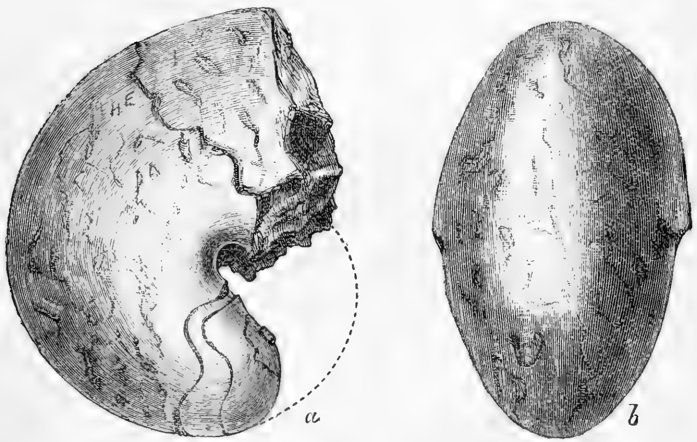
In an excellent figure of this species given by v. Ammon (*loc. cit.*) the anterior border of the shell-muscle is represented upon the cast of the body-chamber.

Horizon. Tithonian.

Localities. Normandy, Escragnolles (Var), France; Randen, near Schaffhausen, Switzerland; Einsingen, Würtemberg.

4. *Nautilus* (*Hercoglossa*) *portlandicus*, sp. nov.

Fig. 3.



Nautilus portlandicus.—*a*, lateral view, showing two of the septa and the siphuncle, which projects a little; *b*, peripheral view. Drawn from a specimen in the British Museum (no. 62165). About one sixth natural size.

Sp. char. Shell subglobose, narrowly rounded on the periphery, gently rounded on the sides, widest immediately above the umbilicus; the latter probably closed, or, if open, exceedingly small. Body-chamber forming probably half a volution. Aperture wider than high. Septa approximate, the sutures forming a very distinct sigmoidal curve on the sides of the shell; in passing over the periphery the sutures are slightly bent backwards. The siphuncle is nearly central. The test is not preserved.

Remarks. The large specimen (B.M. no. 62165) upon which the above description is founded is very imperfect, all the inner whorls are wanting, only the two chambers nearest the body-chamber being preserved; nevertheless the species could be easily recognized by the form of the sutures and the narrowly rounded periphery. The dimensions of the fossil are as follows:—Greatest diameter about 13 inches, greatest breadth about 7½ inches.

Horizon. Portland Oolite *.

Locality. Isle of Portland (?), Dorsetshire.

Cretaceous.

5. *Nautilus radiatus*, J. Sowerby.

1822. *Nautilus radiatus*, J. Sowerby, Min. Conch. vol. iv. p. 78, pl. ccclvi.
1836. *Nautilus radiatus*, Fitton, Trans. Geol. Soc. ser. 2, vol. iv. pt. ii. pp. 204, 367.
1838. *Nautilus radiatus*, d'Archiac, Mém. Soc. Géol. de France, vol. iii. p. 278.
1840. *Nautilus radiatus*, d'Orbigny, Paléontologie Française, Terr. Crét. vol. i. p. 81, pl. xiv.
1845. *Nautilus radiatus*, Ibbetson and Forbes, Quart. Journ. Geol. Soc. vol. i., table facing p. 197.
1845. *Nautilus radiatus*, Forbes, ibid. p. 353.
1849. *Nautilus subradiatus*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. i. p. 145.
1852. *Nautilus squamosus*, Giebel, Fauna der Vorwelt, Band iii. Abth. i. p. 141 (not of Schlotheim).
1853. *Nautilus radiatus*, Sharpe, Description of the Fossil Remains of Mollusca found in the Chalk of England, Memoirs of the Palæontographical Society, pt. i., Cephalopoda, p. 14, pl. v. figs. 1 *a*, 1 *b*, 2.
1854. *Nautilus radiatus*, Morris, Cat. British Fossils, 2nd ed. p. 307.
1859. *Nautilus Neckerianus*, Pictet and Campiche, Descr. des Fossiles du Terr. Crét. des Environs de Sainte Croix, Paléont. Suisse, sér. ii. pt. i. p. 132, pl. xvi.
1862. *Nautilus radiatus*, Bristow and Etheridge, in Bristow's Geology of the Isle of Wight, Mem. Geol. Surv. of Great Britain, Sheet 10, p. 137.
1881. *Nautilus radiatus*?, Etheridge, in H. B. Woodward's Geology of the Country around Norwich, Mem. Geol. Surv. of Great Britain, p. 16.

Sp. char. Shell somewhat compressed upon the sides, rounded upon the periphery; section of the whorls wider

* Portlandien of d'Orbigny.

than high. Umbilicus closed, though open in the cast. Septa rather numerous, slightly curved upon the sides, a very obscure sinus upon the periphery. Siphuncle situated below the centre. Ornaments of the test consisting of numerous, very coarse, prominent, obtuse ridges, separated by interspaces of about half their own width. The ridges are each about 3 lines wide upon the periphery, where they form a narrow backwardly-directed sinus.

Remarks. Pictet and Campiche, in the Pal. Suisse *, have adopted the name *Nautilus Neckerianus* for a form which is evidently identical with Sowerby's *N. radiatus*, and the source of error seems to have been in the locality of the type specimen of the last-named species, which is referred to by Sowerby † in the following words:—"Lately found in the neighbourhood of Maltor, probably in the lower part of the Green Sand formation. I have received but one specimen, a cast in Marly Limestone, mixed with grains of Silex and of blackish Green-earth." Possibly the locality quoted by Pictet and Campiche was taken from the supplementary index to the 'Mineral Conchology' by Mr. John Farey, who gives "New-Malton, E.," as the locality of the type.

We have been able to identify Sowerby's type in the "Sowerby Collection," and the matrix agrees with that described by Sowerby, showing that the specimen came from the Lower Greensand. In its mode of preservation and general appearance as to colour, texture, &c., it closely resembles specimens from the Lower Greensand of Hythe. Without doubt Sowerby's specimen was derived from the Lower Greensand, but we have not been able to obtain any clue as to the locality (Maltor), furnished by him in his description, above quoted.

There seems to be no ground whatever for Young and Bird's statement on p. 271 of their work on the Yorkshire Coast (2nd ed.), that "Sowerby's *N. radiatus* (tab. 256) was found near Malton, most probably in the grey limestone under the Oolite." Those authors were probably misled by the locality given by Farey in the Supplementary Index to vol. iv. of the 'Mineral Conchology.'

Nautilus bifurcatus, Ooster ‡, somewhat resembles the present species, but differs in its more compressed form, and in the possession of fine and numerous longitudinal ridges.

* Sér. ii. pt. i. 1859, p. 132, pl. xvi.

† Min. Conch. vol. iv. 1822, p. 78, pl. ccclvi.

‡ Cat. des Céphalopodes Fossiles des Alpes Suisses, pt. iii. 1858, p. 10, tab. ix. fig. 6, tab. x. figs. 1, 2.

Horizon. Lower Greensand.

Localities. Atherfield, Isle of Wight; Hythe, Sandgate, Kent.

6. *Nautilus neocomiensis*, d'Orbigny.

1768. *Un Nautilite*, &c., Knorr and Walch, Monumens des Catastrophes de la Terre, vol. ii. section i. p. 45, tab. i. fig. 2.
1813. *Nautilus squamosus*, Schlotheim, Taschenb. f. Mineralogie, vol. vii. p. 71.
1840. *Nautilus neocomiensis*, d'Orbigny, Paléontologie Française, (Terr. Crét.), vol. i. p. 74, pl. xi.
1841. *Nautilus neocomiensis*, Duval-Jouve, Belemn. Terr. Crét. p. 10.
1842. *Nautilus neocomiensis*, Matheron, Catalogue Méthodique et Descriptif des Fossiles du Département des Bouches-du-Rhône, p. 259.
1843. *Nautilus neocomiensis*, Favre, Considérations sur le Mont Salève, p. 34.
1849. *Nautilus squamosus*, Quenstedt, Die Cephalopoden, p. 58.
1850. *Nautilus neocomiensis*, d'Orbigny, Prodrome de Paléontologie Stratigraphique, vol. ii. p. 63.
1850. *Nautilus varusensis*, d'Orbigny, Prodrome de Paléontologie Stratigraphique, vol. ii. p. 97.
1852. *Nautilus neocomiensis*, Gras, Catalogue des Corps Organisés Fossiles du Département de l'Isère, p. 24.
1853. *Nautilus neocomiensis*, de Verneuil & Collomb, Bull. Soc. Géol. de France, sér. ii. vol. x. p. 102.
1854. *Nautilus neocomiensis*, Coquand, Mém. Soc. Géol. de France, ser. ii. vol. v. p. 147.
1854. *Nautilus neocomiensis*, Morris, Cat. British Fossils, 2nd ed. p. 307.
1859. *Nautilus neocomiensis*, Pictet & Campiche, Description des Fossiles des Environs de Sainte Croix (Paléontologie Suisse, sér. ii. pt. i. livr. vii.), p. 128, pl. xv.
1860. *Nautilus varusensis*, Pictet & Campiche, ibid. p. 123.
1861. *Nautilus Kayeanus*, Blanford, Mem. Geol. Surv. of India, Palæont. Indica.—I. Cretaceous Cephalopoda of Southern India, p. 31, pl. xvi. figs. 5, 6, pl. xvii. figs. 1, 2, pl. xviii. figs. 1, 2, pl. xxi. fig. 2.
1861. *Nautilus neocomiensis*, Reynés, Études sur le Synchronisme et la Délimitation des Terr.-Crétacés du Sud-Est de la France, p. 33.
1862. *Nautilus neocomiensis*, Bristow and Etheridge, in Bristow's Geology of the Isle of Wight, Mem. Geol. Surv. Great Britain Sheet 10, p. 137.
1866. *Nautilus neocomiensis*, Stoliczka, Mem. Geol. Surv. of India, Palæont. Indica.—I. Cretaceous Cephalopoda of Southern India, p. 210, pl. xvi. figs. 5, 6, pl. xvii. figs. 1, 2, pl. xviii. figs. 1, 2, pl. xxi. fig. 2.
1883. *Nautilus neocomiensis*, Leenhardt, Etude Géologique de la Région du Mont Ventoux, p. 56.

[Not 1853. *Nautilus neocomiensis*, Sharpe, Description of the Fossil Remains of Mollusca found in the Chalk of England, pt. i. Cephalopoda, p. 15, pl. v. figs. 3, *a–c*.]

Sp. char. Shell compressed at the sides, with a narrowly rounded periphery. Umbilicus of moderate size, and exhibiting the inner volutions. Transverse section of the whorls wider than high. Septa very slightly curved upon the sides, and forming a slight sinus upon the periphery. Siphuncle placed a little below the centre. Ornaments of the test consisting of numerous, prominent, obtuse ridges, separated by interspaces about half their own width. These ridges are about 2 lines wide on the periphery, where they form a deep, narrow, backwardly-directed sinus.

Remarks. This species differs from *N. radiatus* by its more compressed form and the much finer ornaments of the test. Moreover, *N. neocomiensis* is stated by d'Orbigny to have been found only in the middle beds of the Neocomian, while *N. radiatus* was peculiar to the Craie glauconieuse ("Craie chloritée" of d'Orbigny and the older authors), none being found in the intermediate beds.

N. squamosus, Lange (Schlotheim), and *N. varusensis*, d'Orbigny, are placed in the synonymy of the present species on the authority of MM. Pictet and Campiche. Of the former those authors affirm that Quenstedt was quite in error in supposing it to be identical with the *neocomiensis* of d'Orbigny, the *N. squamosus* of Lange being a smooth species from the Jurassic rocks of the neighbourhood of Baden. Of the latter (*N. varusensis*) the same authors remark that the short description given of it by d'Orbigny indicates no appreciable difference between it and *neocomiensis*.

Stoliczka * held that the *Nautilus Kayeanus* of Blanford was identical with *N. neocomiensis*, having arrived at that conclusion by a comparison of actual specimens of the European with the Indian fossils. He finds, it is true, that Pictet's specimens have generally a smaller number of septa (about 15 to a whorl) than the Indian ones, but the latter agree perfectly with d'Orbigny's original figure of *N. neocomiensis*, and, he adds, an equal number of septa, about 20, are to be observed on specimens from Escragnolles, the typical locality of d'Orbigny's species.

Horizon. Neocomian.

Localities. Grasse, Escragnolles (Var), France; Neuchâtel, High Alp (Sentis), Appenzell, Switzerland.

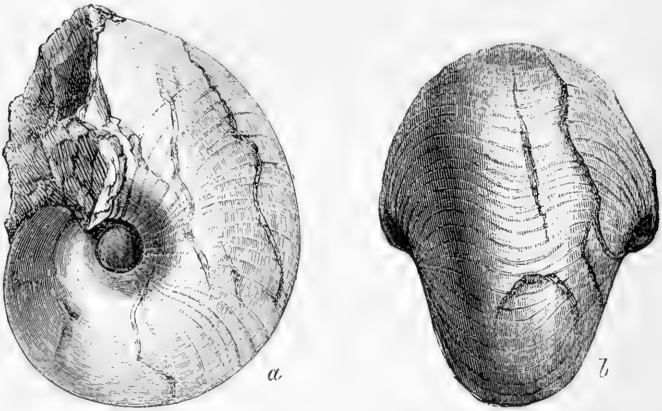
7. *Nautilus hunstantonensis*, sp. nov.

Sp. char. Shell moderately inflated, slightly compressed on the sides, rounded on the periphery, widest part of the whorls in the umbilical region. Umbilicus small, deep, with steeply

* Mem. Geol. Surv. India, Palæont. Indica.—Cretaceous Cephalopoda of Southern India, 1866, p. 210.

sloping sides and rounded edges. Septa rather wide apart, fourteen to a whorl in a specimen whose diameter is 3 inches (fig. 5). Siphuncle a little above the centre in the young

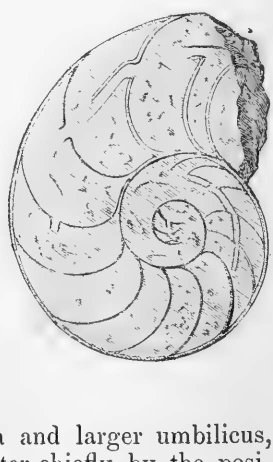
Fig. 4.



Nautilus hunstantonensis.—*a*, lateral view, showing the open umbilicus; *b*, peripheral view, showing the lines of growth. Drawn from a specimen in the British Museum (no. C. 932), presented by J. E. Lee, Esq., F.G.S. About one half natural size.

shell, but getting much nearer the peripheral margin in the process of growth, as may be seen in the accompanying section (fig. 5), which is drawn (about three fifths nat. size) from a specimen in the British Museum (no. C. 82449). Surface of the test ornamented with obscure and irregular plications, commencing in the umbilicus, where they are most distinct, but becoming less so as they approach the periphery. Fine lines of growth cover the whole of the test.

Fig. 5.



Remarks. There are two species in the Gault with which the present one may be compared, viz. *Nautilus Bouchardianus*, d'Orbigny, and *N. Montmollini*, Pictet and Campiche. Our species agrees with the former of these in the position of its siphuncle, but differs in its more numerous septa and larger umbilicus, while it is distinguished from the latter chiefly by the position of its siphuncle, somewhat larger umbilicus, and more inflated whorls.

The gradual shifting of the position of the siphuncle in the present species from a central position in the young to a nearly external position in the adult is a feature met with in other species; Stoliczka has observed it in *Nautilus Huxleyanus*, Blanford, and in *N. sphæricus*, Forbes, and other species *.

Many authors have recorded the occurrence of various species of *Nautilus* in the Red Chalk or Hunstanton Limestone †; but the present form does not appear yet to have been characterized.

Horizon. Red Chalk.

Locality. Hunstanton, Norfolk.

8. *Nautilus triangularis*, Montfort.

1802. *Nautilite triangulaire*, Montfort, in his edition of Sonnini's "Suite à Buffon" (Hist. Nat. des Mollusques, An. x.), vol. iv. p. 292, pl. xlix. fig. 2.
1808. *Nautilus triangularis*, Montfort, Conch. Syst. p. 7 (*G. angulithes*).
1820. *Nautilites angulites*, Schlotheim, Die Petrefactenkunde, p. 84.
1832. *Nautilus triangularis*, Passy, Descr. Géol. de la Seine-Inférieure, p. 334.
1834. *Nautilus triangularis*, d'Archiac, Mém. Soc. Géol. de France, vol. ii. pt. ii. p. 191.
1840. *Nautilus triangularis*, d'Orbigny, Paléontologie Française, Terr. Crét., vol. i. p. 79, pl. xii.
1842. *Nautilus triangularis*, Matheron, Cat. Méth. et Descrip. des Fossiles du Départ. des Bouches-du-Rhône et Lieux Circonvoisins, p. 259.
1850. *Nautilus triangularis*, d'Orbigny, Prodrome de Paléontologie Stratigraphique, vol. ii. p. 145.
1852. *Nautilus triangularis*, Giebel, Fauna der Vorwelt, Band iii. Abth. i. p. 162.
1854. *Nautilus triangularis*, Millet, Paléontologie de Maine et Loire, p. 103.

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* Mem. Geol. Surv. India, Palæont. Indica, ser. iii. 1866, p. 205.

† The following are some of the principal references:—

(1) Samuel Woodward, 'An Outline of the Geology of Norfolk,' 1833, p. 54.—*Nautilus elegans.*

(2) Rev. Thomas Wiltshire, "On the Red Chalk of England," Geol. Assoc. 1859, p. 17, pl. i. fig. 3.—*Nautilus simplex.*

(3) H. G. Seeley, "Notice of Opinions on the Stratigraphical Position of the Red Limestone of Hunstanton," Ann. & Mag. Nat. Hist. ser. 3, vol. vii. 1861, p. 244.—*Nautilus simplex.*

(4) Rev. T. Wiltshire, "On the Red Chalk of Hunstanton," Quart. Journ. Geol. Soc. vol. xxv. 1869, p. 185.—*Nautilus albensis, N. Bouchardianus.*

(5) W. Hill, "On the Lower Beds of the Upper Cretaceous Series in Lincolnshire and Yorkshire," Quart. Journ. Geol. Soc. vol. xliv. 1888, p. 347.—*Nautilus*, sp.

1859. *Nautilus triangularis*, Pictet & Campiche, Description des Fossiles du Terrain Crétacé des Environs de Sainte-Croix (Paléontologie Suisse), sér. ii. pt. i. pp. 141, 149.
1861. *Nautilus triangularis*, Reynés, Etudes sur le Synchronisme et la Délimitation des Terr.-Crétacés du Sud-Est de la France, p. 41.
1866. *Nautilus triangularis*, Beltremieux, Faune Fossile du Département de la Charente-Inférieure, pp. 43, 80.

Sp. char. Shell compressed, smooth, with the periphery alternately rounded and sharply angular ; umbilicus closed ; section triangular, the sides very slightly rounded, deeply emarginated by the preceding whorl. Septa considerably curved upon the sides, and projecting forwards upon the peripheral angle, slightly bent backwards in the umbilicus. According to d'Orbigny the siphuncle is situated below the centre, not far from the ventral border. Test unknown.

Remarks. This species is readily distinguished from *Nautilus Fleuriausianus*, d'Orbigny, as figured and described in the 'Pal. Franç.' (Terr. Crét. vol. i. p. 82, 1840, pl. xv.) by its sharply angular periphery at different stages of growth. D'Orbigny in his 'Prodrome' (vol. ii. 1850, p. 145) makes his *Nautilus Fleuriausianus* a synonym of the present species, but he gives no reason for so doing, and we have no evidence to show that *N. Fleuriausianus* underwent the same changes of form as those noticed in *N. triangularis.* These remarkable changes were pointed out by M. Ed. Guéranger in a paper read before the Geological Society of France (Bull. sér. ii. vol. vii. 1850, p. 803), and he thus described them :—"Un caractère particulier et inédit est d'avoir le dos de la spire alternativement anguleux ou en carène, et parfaitement arrondi ;" . . . Stoliczka * considers also that these forms are quite distinct.

Horizon. Lower Chalk (England). Upper Greensand (France).

Localities. Sidmouth, Devonshire ; Folkstone, Kent ; Escragnolles (Var), France.

9. *Nautilus libanoticus*, sp. nov.

1878. *Ammonites Traskii*, O. Fraas, Aus dem Orient, Theil ii. Geol. Beobachtungen am Libanon, p. 97, Taf. iv. fig. 4 (not of Gabb).

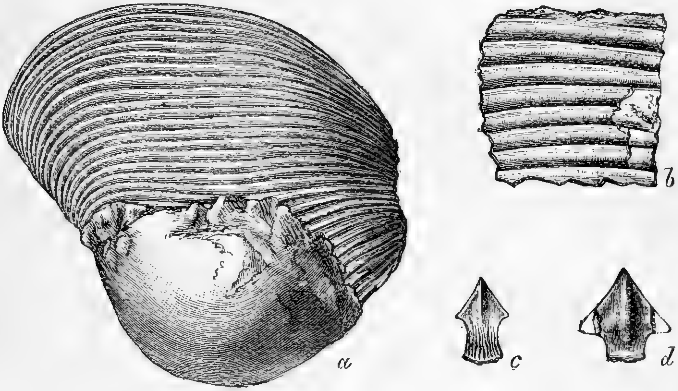
Sp. char. Shell much inflated, rapidly increasing, broadest in the umbilical region. Umbilicus probably closed. Test ornamented with prominent acute ribs, separated by interspaces rather exceeding their own width. Some of the ribs bifurcate in the region of the umbilicus.

Remarks. All the specimens are casts more or less crushed

* Mem. Geol. Surv. India, Palæont. Indica, ser. ii. 1866, p. 207.

and distorted, and nothing is seen in them of the septa or siphuncle; nevertheless the ornaments of the test are sufficient to distinguish the species from others which it may resemble. The general form of *N. libanoticus* suggests that of *N. elegans*, J. Sowerby, but the character of the ornaments in the latter differs from that of the former, the ribs being at once broader and closer together in Sowerby's species than

Fig. 6.



Nautilus libanoticus.—*a*, peripheral view of a distorted specimen (no. C. 542); *b*, portion of the test of another specimen (no. C. 542 *a*); *c*, beak from specimen no. 83663; *d*, beak from no. C. 2918. Drawn from specimens in the British Museum. *a* rather exceeding one half natural size; *b* natural size; *c* and *d* one and a half times natural size.

they are in the present one; and this distinction is maintained even in casts. Fortunately one of our specimens has a portion of the test preserved, and it is here figured (fig. 6, *b*). The beaks are exposed to view on the ventral surface of the body-chambers of several of the specimens (fig. 6, *c*, *d*).

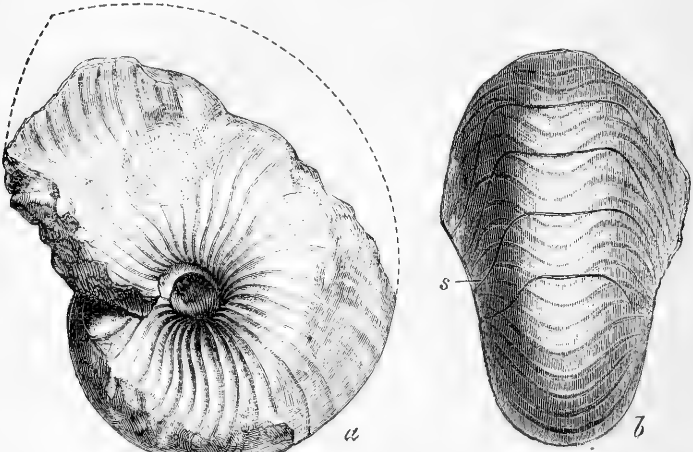
Horizon. Upper Cretaceous.

Locality. Sâhil Alma, Lebanon, Syria.

10. *Nautilus Bayfieldi*, sp. nov.

Sp. char. Shell somewhat compressed upon the sides and a little flattened upon the periphery, the thickest part of the whorls being in the umbilical region. The umbilicus is rather small, with steeply sloping sides and rounded borders; the inner whorls partly exposed. The whorls present a subtriangular outline in section, owing to the flattening of the sides and the superior width of the dorsal as compared with the ventral or peripheral side. The septa are moderately distant, being about 7 lines apart where the height of the whorl is $1\frac{1}{3}$ inch. The sutures are slightly bent backwards

Fig. 7.



Nautilus Bayfieldi.—*a*, lateral view of a specimen, showing the umbilicus and the ribs ornamenting the test; *b*, peripheral view of another specimen, showing sutures (*s*) and ribs. Drawn from specimens in the British Museum (*a*, no. C. 3103; *b*, no. C. 3102), about two thirds natural size.

on the sides of the shell and form a shallow sinus on the periphery. There appears to be an inner lobe. The siphuncle is situated a little below the centre. The test is ornamented with numerous acute transverse ribs or plications, separated from each other by spaces about equal to their own width. The ribs form a deep sinus in crossing the periphery.

Remarks. This species is closely allied to *Nautilus patens*, Kner *, from which, however, it differs in its more compressed whorls, smaller umbilicus, and the position of its siphuncle, which is below instead of being above the centre. The present species bears some resemblance to *Nautilus Deslongchampsianus*, d'Orb.†; but the latter has a more inflated shell, a distinctly angular umbilical border, and longitudinal as well as transverse ornaments.

* 'Versteinerungen des Kreidemergels von Lemberg und seiner Umgebung,' p. 7, tab. i. figs. 2, 2*a*. See also Dr. Clemens Schlüter, "Cephalopoden der oberen Deutschen Kreide," in Palæontographica, Band xxiv. Lief. 1, April 1876, p. 178, Taf. 1.

† Paléont. Française (Terr. Crét.), vol. i. p. 90, pl. xx.

We have pleasure in associating with this species the name of Mr. T. G. Bayfield, of Norwich, from whose fine collection of Upper-Chalk fossils all the examples of this species, now in the British Museum, were derived.

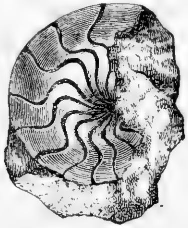
Horizon. Upper Chalk.

Locality. Norwich.

11. *Nautilus* (*Hercoglossa*) *danicus*, Schlotheim, sp.

1820. *Nautilus danicus*, Schlotheim, Die Petrefactenkunde, p. 83.
1834. *Nautilus danicus*, v. Buch, Neues Jahrbuch für Mineralogie, &c. p. 533.
1835. *Nautilus danicus*, Beck, Proceed. Geol. Soc. vol. ii. p. 218.
1837. *Nautilus danicus*, Lyell, Trans. Geol. Soc. vol. v. pt. i. p. 250, pl. xviii. figs. 4–7.
1837. *Nautilus danicus*, von Buch, Ueber den Jura in Deutschland (Akad. der Wissensch.), p. 119.
1850. *Nautilus danicus*, Geinitz, Das Quadersandsteingebirge oder Kreidegebirge in Deutschland, p. 110.
1850. *Nautilus danicus*, d'Orbigny, Prodr. de Paléont. Stratigr. vol. ii. p. 290.
1851. *Nautilus danicus*, d'Orbigny, Neues Jahrbuch für Mineralogie, p. 101.
1852. *Nautilus danicus*, Giebel, Fauna der Vorwelt, Band. iii. Abth. i. p. 138.
1861. *Nautilus danicus*, Binkhorst, Mon. des Gastéropodes et des Céphalopodes de la Craie Supérieur du Limbourg, pt. ii. p. 16.
1865. *Nautilus danicus*, Blanford, Mem. Geol. Surv. India, Palæont. Indica, Foss. Ceph. Cretaceous Rocks of S. India, p. 24, pl. x. figs. 4, 4 *a*, pl. xi.
1865. *Nautilus danicus*, Stoliczka, ibid. p. 208.
1868. *Nautilus danicus*, Dewalque, Prodrome d'une Description Géologique de la Belgique, p. 358.
1868. *Nautilus danicus*, Stoliczka, Records Geol. Surv. India, no. 2, p. 32.

Fig. 8.



Nautilus (*Hercoglossa*) *danicus*.—Lateral view of a young example, showing the curvature of the sutures. Drawn from a specimen in the British Museum (no. C. 3106). Natural size.

Sp. char. Shell subinflated, flattened on the sides, narrowly rounded on the periphery; umbilicus closed. Septa moderately distant, being 5 lines apart on the periphery, where the height of the whorl is 11 lines. Sutures forming an acute, forwardly-directed lobe near the umbilicus, then bending backwards into a somewhat broader lobe, and again directed forwards towards the periphery, in crossing which they make a broad arch. There is a very distinct internal (dorsal) lobe in young specimens. The siphuncle is a little below the centre. The body-chamber and test are unknown.

Remarks. This species is distinguished from *Nautilus franconicus* by the form of its shell, which has a rounded instead of a truncated periphery; its siphuncle also is differently placed. There is no species in the Chalk of Europe with which it may be compared. *N. danicus* has been recognized by H. F. Blanford * in the upper part of the Arrialoor Group (Cretaceous) of Southern India. Mr. Blanford found that the only difference between the Indian specimens and the figures of *N. danicus* given by Lyell in the Trans. Geol. Soc. (*loc. cit.*) was "a somewhat greater compression of form" in some of the former; this he found, however, to be a variable character in the Indian specimens. He remarks that the very large size to which the Trichinopoly specimens occasionally attain can scarcely be regarded as a specific character. The internal lobe is present in young examples of the Indian specimens, disappearing in older ones. In the volume already quoted † Stoliczka has the following remarks on the present species:—"So far as the existing figures of *N. danicus* [Trans. Geol. Soc., *loc. cit.*] allow an opinion to be formed, the Indian fossil does not vary from the European, except in the usually greater thickness of the whorls." The following species from the Cretaceous rocks of Southern India form a group of which *N. danicus* is the European representative, viz. *N. serpentinus*, Blanford ‡, *N. Forbesianus*, Blanford §, *N. trichinopolitensis*, Blanford ||.

Horizon. Upper Chalk.

Locality. Faxoe, Denmark.

Tertiary.

12. *Nautilus* (*Hercoglossa*) *Cassinianus*, sp. nov.

[*Aturia Cassiniana*, Edwards, MS.]

Sp. char. Shell compressed, with flattened sides and narrowly rounded periphery. Greatest thickness in the region

* Mem. Geol. Surv. India, Palæont. Indica, 1861, series i. Cret. Ceph. of Southern India, p. 24.

† Mem. Geol. Surv. India, Palæont. Indica, 1866, series iii. Cret. Ceph. of Southern India, p. 208.

‡ Mem. Geol. Surv. India, Palæont. Indica, ser. i. 1861, p. 25, pl. xii. figs. 1, 1 *a*; ibid. ser. iii. 1866, p. 208, pl. xcii. fig. 2.

§ Ibid. p. 26, pl. xiii.

|| Ibid. p. 37, pl. xxiii., pl. xxiv. figs. 1, 2; ibid. ser. iii. 1866, p. 212.

of the umbilicus; the latter closed. Septa approximate, sutures forming a sharply-bent, forwardly-directed lobe after

Fig. 9.

Nautilus (Hercoglossa) Cassinianus.—*a*, lateral view of a fragment, showing the curvature of the sutures; *b*, front view, showing the position of the siphuncle. Drawn from a specimen in the British Museum (no. 71003). Natural size.

leaving the umbilicus, then bent backwards in a similar lobe, and finally directed forwards towards the periphery, which they cross with a narrow arch. Siphuncle situated below the centre.

Remarks. This species closely resembles *Nautilus* (*Hercoglossa*) *danicus*, but is easily distinguished by its more compressed whorls and the position of its siphuncle. It may be added that the close proximity of these species in the geological series (*N.* (*H.*) *danicus* from the uppermost beds of the Chalk, and *N.* (*H.*) *Cassinianus* from the Lower Eocene) renders their near relationship highly probable.

The name of this species is taken from a list of the Edwards Collection of Fossils now in the British Museum, but the species was never described. Edwards erroneously placed it in the genus *Aturia*.

Horizon. London Clay (Lower Eocene).

Localities. Finchley, Middlesex (Edwards's type); Isle of Sheppey.

L.—*Further Descriptions of new Coleoptera of the Family* Scarabæidæ *in the British Museum.* By CHARLES O. WATERHOUSE.

SINCE my last paper was written (*suprà*, p. 365) I have, by the kindness of Mr. D. Sharp, been able to examine the type specimens of the species of *Gymnopleurus* described by him. I think that in this genus, as in so many other Coprophaga, there are two forms of males, a major and a minor form, the major form having the anterior tibiæ more inflexed at the apex and the posterior angles of the thorax more dilated than in the minor form, which more approaches the female. The series of *G. sinuatus* and *G. assamensis* in the British-Museum Collection show this I think very distinctly. I believe the species of this group described by Mr. Sharp are all good species, except *G. calcar* and *G. celebicus*, which, in my opinion, are major and minor forms of the same species; *G. dubius*, on the other hand, which has been considered the female of *G. calcar* by von Harold, appears to me to be possibly distinct, or it may be merely a large female.

Gymnopleurus Hornei.

Oblongus, subparallelus, parum convexus, niger; thorace fortiter reticulato-foveolato; elytris surdis, coriaceis, striatis, interstitiis maculis parvis irregularibus parum elevatis nitidis ornatis.
Long. $4\frac{2}{3}$ lin.

Hab. N.W. India (*C. Horne, Esq.*).

Allied to *G. flagellatus*, F., but smaller and rather more parallel. The head is of the same form, triangularly incised in front, closely foveolate-punctate posteriorly. The thorax is less broad, more rounded at the hind angles, marked with closely placed dull foveæ, which are irregular in size, but are relatively larger than in *G. flagellatus*, so that the interspaces are generally very narrow and form a sort of shining network; each fovea has a minute shining tubercle in its centre. The elytra are dull, finely coriaceous, striated as in *G. flagellatus*, the interstices having a series of small, very irregular, slightly raised, shining spots, somewhat as in *Silpha rugosa*; metasternum more coarsely foveolate than in *G. flagellatus*; lateral exposed margin of the abdomen not carinate.

Gymnopleurus singularis.

Oblongus, parum convexus, supra obscure cupreus, surdus, subtus niger, nitidus; thorace subtilissime coriaceo, sat crebre subtiliter punctato, lateribus medio angulatis dein paulo sinuatis, angulis posticis obtusis paulo retrorsum productis; elytris subtilissime coriaceis, striatis, interstitiis guttis minutis nitidis crebre aspersis.
Long. $8\frac{1}{2}$ lin.

Hab. Corea (*Sir E. Belcher*).

Closely allied to *G. sinuatus*, of a dull coppery colour shaded with black, and with a silky appearance. The back part of the head is dull, coriaceous, with minute asperate punctures. Thorax very finely but distinctly punctured, the punctures separated generally by three or four diameters of a puncture, the punctures towards the sides appearing slightly asperate. The sides are distinctly but obtusely angular at the middle, and immediately behind this angulation there is a slight but distinct sinuosity; from this point to the base the sides are gently curved inwards and the margins are thickened; the posterior angles are slightly produced backwards, the produced part obtusely rounded. The elytra are finely coriaceous, distinctly striated, the striæ indistinctly punctured, the interstices flat, with rather closely placed, minute, shining dots. The metasternum has an impressed median line, which widens out into a somewhat deep impression posteriorly; the anterior part is slightly swollen in the middle; the sloping sides with shining granules.

This species is very close to *G. maurus*, Sharp; but that species is black and has the sides of the thorax more distinctly angular.

Gymnopleurus assamensis.

Parum convexus, supra cupreus, subtus cupreo-niger, parum nitidus; thorace subtiliter coriaceo, punctis parvis sat crebre asperso, ante medium oblique angustato, postice subparallelo, angulis postice rectangularibus, sat obtusis; elytris tenuiter striatis, striis punctis minutis haud approximatis instructis, interstitiis subtilissime coriaceis et crebre tenuiter nitido-granulosis; antennis ferrugineo-flavis, basi nigris.

Long. $6\frac{1}{2}$–10 lin.

Hab. N.W. India, Sylhet, Assam, Corea.

This species is well known in collections under the above name, but does not appear to have been described. It closely resembles *G. sinuatus*, but is coppery in colour and more finely sculptured, and consequently is less dull; the sides of the thorax are more distinctly angular.

Gymnopleurus brahminus.

Niger, opacus, supra omnino æqualiter subtiliter granulosus; thorace ante medium oblique angustato, postice perparum angustiore fere parallelo, angulis posticis vix prominulis; elytris leviter striatis.

Long. $9\frac{1}{2}$ lin.

Hab. China (*J. C. Bowring, Esq.*).

This species is close to *G. sinuatus*, but is quite black and dull and differently sculptured. The thorax is obtusely angular at the middle of the sides, scarcely narrowed towards the base, almost parallel, with the posterior angles less prominent than in *G. sinuatus*, but a little more so than in *G. melanarius*, the angles themselves obliquely rounded off.

The surface is evenly and closely covered with minute, but distinct round or oval depressed granules, and is without punctures. The elytra have the surface extremely finely coriaceous, and covered with minute but distinct round granules, which are a trifle smaller than those on the thorax, and not quite so crowded, so that the coriaceous surface is visible in the very narrow interspaces. The anterior part of the metasternum is a little more sloping than in *G. sinuatus*, and although slightly convex, there is no distinct swelling in the middle.

Megathopa cupreicollis.

Oblongo-ovalis, convexus, cupreo-æneus; capite antice rugato, nigro, vertice sat fortiter punctato; thorace nitido, parum sericeo, subtilissime punctulato; elytris nigro-cyaneis, parum nitidis, sericeo-coriaceis, basi angustatis, convexis, distincte striato-punctatis, interstitiis planis, guttis minutissimis nitidis crebre aspersis; pygidio fortiter sat crebre punctato.

Long. 7 lin.

Hab. Peru.

The punctures on the vertex of the head are strong and rather close together. The thorax has the posterior angles even more obliquely rounded than is usual; the punctures are extremely fine but moderately distinct, moderately near together; with a strong magnifying-glass, very minute punctures may be seen in the intervals. The elytra are much narrowed at the base, moderately convex, with lines of very distinct, moderately closely placed punctures, with scarcely any trace of striæ. The pygidium is obscure green, with rather strong dark punctures, which are separated from each other by one to one and a half diameters; metasternum apparently impunctate in the middle, with strong punctures at the sides; antennæ pale ferruginous.

This species has the sides of the thorax gently sinuate in front of the middle, as in *M. bicolor*, with a projection in front of it, the projecting part itself gently sinuate.

Megathopa virens, Harold, var.?

Oblongo-ovalis, minus convexus, nitidus, nigro-cæruleus; capite vertice punctato, antice rugato; thorace lævi, lateribus medio angulatis, impressis; elytris subtilissime rugosis, fere lævibus, lævissime striatis, striis impunctatis, interstitiis planis; pygidio basi lævissimo, dimidio apicali confertim rugoso-punctato, flavo-pubescente.

Long. $9\frac{1}{2}$ lin.

Hab. Brazil?

This is the smoothest species known to me; the thorax has the sides distinctly but obtusely angular and impressed, without any projection before the front angles, the angles themselves slightly acute and diverging; the elytra have the striæ scarcely noticeable, except at the apex; the metasternum is entirely smooth, including the sides.

Megathopa æneicollis.

Oblongus, convexus, sat nitidus, æneus, piceo-tinctus; capite postice punctato, medio læviore, antice rugato; thorace medio lævi, lateribus et basi sat fortiter punctatis, lateribus medio angulatis, impressis, angulis anticis fere rectis; elytris minus nitidis, sat fortiter striatis, striis punctatis, interstitiis leviter convexis, subtilissime coriaceis piceo ænoque mutantibus; stria octava basi cariniformi; pygidio piceo, fortiter punctato; metasterno medio lævi, ad latera et antice fortiter parce punctato.

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

Hab. Brazil.

This species is allied to *M. columbica*, Harold, but has the sides of the thorax strongly punctured.

BIBLIOGRAPHICAL NOTICE.

Memoir on the Anatomy of the Humpback Whale (Megaptera longimana, *Rudolphi*). By John Struthers, M.D. Edinburgh: Maclachlan & Stewart, 1889.

In this volume Prof. Struthers gives us the various observations * he made on the anatomy of the male Humpback Whale, 40 feet in length, which for five or six weeks disported itself in the Tay, at the end of 1883. The proximity of experienced whalers in Dundee, however, at length proved fatal to the interesting cetacean, as it fed on the young herrings and sprats, and other pelagic forms in the estuary. It was harpooned on the last day of December, but in no vital part, since the harpoons struck too high, and after a chase of twenty-one hours, in which it exhibited remarkable strength and endurance, the lines parted on the morning of 1st January and it was free. Shock, loss of blood, and the exhaustion of the chase, for it dragged for a time a steam-tug, a steam-launch, and two rowing-boats, proved too much for it, and it would seem to have died shortly afterwards without again venturing into St. Andrews Bay, otherwise the destination of the skeleton might have been different.

* Which appeared in the 'Journal of Anatomy and Physiology,' 1887-1889.

About a week afterwards the carcass, floated by the gases, was towed into Stonehaven and thence to Dundee.

The external characters are drawn up from views of the Whale as it lay on its dorsum at Stonehaven, and an accurate series of measurements is given of the various parts. The position in which the author at first examined the specimen prevented him from forming an accurate opinion with regard to the colour of the dorsal surface of the great flipper, but it really was entirely white, as described by Lilljeborg * and as stated in Bell's 'British Quadrupeds' †. The outline of the hump given by Prof. Struthers also differs from a sketch made on its arrival in Dundee, in so far that the posterior border was less acute distally. A more important divergence in external configuration, however, has been made by the author in regard to the tail, which, instead of having, as in his figure, a somewhat uniform line of fimbriæ posteriorly, presented on each side of the median hiatus (which is also deeper than shown) a prominent flap with four points. Thus the outline of the tail posteriorly was characteristic.

Amongst other interesting features described by the author are the mamillary pouch containing the small mammæ of the male, the hairs of the muzzle, and the whalebone.

In the second part of the treatise the anterior limbs and the rudimentary posterior limbs are elaborately examined, and contrasted with the same parts in *Balænoptera musculus*, the type with which the author compares throughout. The greater size of all the parts in *Megaptera* is clearly brought out; the proportions of the hand to the arm and forearm and the elongation of the phalanges being diagnostic, and fully explaining the nodulated condition of the flipper of *Megaptera*. It is noteworthy, however, that the finger-muscles are less than half the size of those of *B. musculus*, while the tendons showed an increase. The elaborate measurements, and even weights, of the various elements do credit to Dr. Struthers's assiduity. The hind limb is represented by a partially ossified pelvic bone supporting the *crura penis*, and a cartilaginous femur, the functions of which latter are obscure.

The third part treats of the vertebral column, which is characterized by the shortness of the bodies of the vertebræ when contrasted with those of other finners. The greatest vertebral body in *Megaptera* is the second of its 21 caudal vertebræ—the 33rd of its 52 vertebræ. A careful survey of the epiphyses, ridges, costal marks, hæmal tubercles and foramina, of the neural arches and canal, of the articular and other processes is given. The differences also between the various parts of this species and *B. musculus* are shown, such as the breaking up of the anterior border of the spinous process in *Megaptera*, and a decided triangular mesial projection on the posterior articular process of the last lumbar and first two caudal in the same species. In regard to the transverse processes,

* Scandinavian Cetacea, Flower, Ray Soc. p. 289 (1866).
† 2nd edition, London, 1874.

a few of the chief features are, their absence on the 15 posterior caudal vertebræ, and the upturning of the dorsal transverse processes. The spinous processes, again, are rhomboidal, in contrast with the battle-door shape of those of *B. musculus.*

The differences of the transverse processes of the axis in the two forms are interesting. Thus the upper and lower processes unite in *B. musculus*, forming a great common terminal plate external to the ring, whereas in *Megaptera* the ends of the processes are three inches apart. Generally the separated cervical vertebræ in *Megaptera* are of less breadth compared with the height than in *B. musculus*, and their structure would indicate more movement in the former than in the latter.

After the elaborate disquisition on the vertebræ, the author next discourses on the ribs. These are thicker and more curved in *Megaptera*, and they present a less distinct angle and external neck. They moreover enclose a proportionally larger thoracic cavity than in *B. musculus.* The sternum is narrower than in the latter, and the first rib lies behind the wing of the sternum. In this example of *Megaptera* also there was a wide oblique notch at the end of the first rib, best marked on the right.

The chevron bones are fewer than in *B. musculus*, and they have a wider arch at the top. The spines are less developed than in *B. musculus.*

The last part of the treatise contains an account of the skull, which is proportionally larger in *Megaptera*, its greater breadth being especially diagnostic. It has a large foramen magnum, the occipital plate of the temporal is also larger, and the temporal fossa is shorter and more posterior in position. The parietal has much greater expansion on the temporal fossa in *Megaptera*, and the sphenoid does not show itself on the surface. The differences in regard to the pterygoid, palate (which characteristically sends up a triangular process pushing the pterygoid outwards), and the broader malar in *Megaptera* are all carefully detailed. The characters of the orbit, transverse frontal fossa, nasal bones (fitted to a triangular spine of the frontals), anterior and posterior nares, ethmo-turbinals, and vomer are next examined, and the differences in contrast with *B. musculus* pointed out. In *Megaptera* also the maxillaries and premaxillaries present a marked fall for 7 or 8 inches along the beak, and they are much inclined inwards at and anterior to the nasals. The deficiences of the grooves in the palatal roof further distinguish *Megaptera* from *B. musculus.* The greater breadth of the median beam in the former is also noteworthy, and its brain-cavity is also broader; the tympanic bone is shorter in proportion to its breadth in *Megaptera*, and the form of the posterior division of the periotic is of special interest in connexion with Dr. Gray's remarks on *Megaptera novæ-zealandiæ*, the figure of the part in the latter presenting a close resemblance.

The treatise concludes with an account of the differences in the mandible and hyoid in the two species. Thus the coronoid process of the former is shorter, the dental foramen is nearer the condyle in *Megaptera*, which also has a greater curvature and thickness of the body of the mandible, and shorter horns to the hyoid bone.

It is unfortunate that the soft parts of the Tay Whale were so decayed as to be useless for investigation, since many important features, *e. g.* the condition of the mucous membrane of the jejunum, were thus placed beyond the reach of the anatomist.

The work is a noteworthy contribution to the anatomy of *Megaptera*, though, perhaps, its interest and value might have been increased if more frequent references had been made to the labours of previous observers. A clearer conception of what has and what has not been previously described would thus have been obtained. Dr. Struthers, indeed, is to be congratulated on this further addition to his researches on the Cetacea, and though his official duties (from which, it is much to be regretted, ill-health has now relieved him) may have hampered and limited his work, yet this treatise is evidence of that scientific enthusiasm for which Scotch anatomists, such as the earlier Monros, Goodsir, and Turner, have been so famous. We look forward to further contributions from the pen of Dr. Struthers. W. C. M.

MISCELLANEOUS.

On Excavations made in Rocks by Sea-Urchins. By J. Walter Fewkes *.

The author has had an opportunity of observing excavations made by *Strongylocentrotus dröbachiensis* on the coast of Grand Manan, New Brunswick, where the reefs of hard mica-schist with veins of harder quartzite are bare at low tide but covered at high water. The cavities were so numerous that the rock was roughly honeycombed with these shallow excavations, and, moreover, spreading Algæ (*Lithothamnion* and *Melobesia*) sometimes covered the rock and the cavities. The author, indeed, thinks the presence of the latter may be necessary to the Sea-Urchins "for some reason." It would be as useful, however, to speculate on the relation of the same to the boring Annelids, unless the Algæ are eaten by the Echini—just as the common British *Echinus* fills its intestine with fragments of the stems of *Laminariæ*, with perhaps a few fragments of the tubes of *Serpulæ*. He gives some interesting observations on the borings of *E. lividus* in pot-holes at Biarritz by Prof. Jules Marcou. In regard to the *modus operandi* of the borers Mr. Fewkes, after previous observers, gives the chief weight to the dental apparatus, probably assisted by the voluntary movements of the spines and the involuntary action caused by the waves moving the animal *in situ*. Two interesting plates illustrate the paper. W. C. M.

* 'American Naturalist,' January 1890.

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LI.—*On the Morphology and Phylogeny of the Organization of the Cestoda.* By C. CLAUS *.

FOR a number of years past I have represented in my lectures a view of the nature of the Cestode body which differs materially from that propounded by Steenstrup and strengthened by the researches of von Siebold, van Beneden, and Rudolph Leuckart: nevertheless the *ensemble* of the facts and the results of numerous later investigations prove it to be the only true and satisfactory one. The main features of this altered view of the case, which, moreover, in many respects does not differ so very widely from Rud. Leuckart's latest treatise on the Helminthes†, are to be found briefly indicated in the latest editions of my text-books ‡; but, so far as I am aware, a more precise explanation of my theory on a directly comparative basis has not yet been attempted. The following brief account is intended to supply this deficiency.

* Translated from the 'Arbeiten aus dem Zoologischen Institute der Universität Wien und der Zoologischen Station in Triest,' Bd. viii. Heft iii.: Alfred Hölder, Vienna, 1889.

† Rud. Leuckart, 'Die Parasiten des Menschen und die von ihnen herrührenden Krankheiten, Ein Hand- und Lehrbuch für Naturforscher und Aerzte,' Leipzig, 1879–1886, Bd. i.

‡ C. Claus, 'Grundzüge der Zoologie,' Marburg, 1879, IV. Aufl. Bd. i. ii. Lieferung, p. 388 &c.; 'Lehrbuch der Zoologie,' Illustrirte Ausgaben, ii., iii., and iv. Aufl.

As is well known, it was the "proglottis," the segment full of ova and embryos and liberated from the body of the Cestode, which, in accordance with the doctrine of Alternation of Generations, was held to be the sexual individual and furnished the starting-point for a comparison with the closely allied but higher organized Trematodes. The proglottis was regarded as the equivalent of the Trematode, which, arising by means of terminal gemmation at the posterior end of an individual belonging to another generation and functioning as "nurse-form"—the Cestode-head or "scolex," with the loss of mouth, alimentary canal, and organs of adhesion, did actually possess the latter, in common with all the other joints of the chain, while it formed part of the chain of segments, in the shape of the circlet of hooks and the suckers of the scolex. The fact that there are Cestodes which are devoid of any trace of segmentation (e. g. *Caryophyllæus*), and in whose simple Trematode-like body scolex and proglottis are not differentiated, appeared to agree very well with this view, and was explained as a secondary condition, inasmuch as it was supposed that the forms which are spread over two generations in the case of the ordinary Cestode were, just as in other cases of alternation of generations, as a result of simplified and abbreviated development united together again in one individual (Rud. Leuckart). But the *ensemble* of the phenomena proves that in point of fact exactly the opposite condition obtains, and that alternation of generations in the Cestodes must be regarded not as a primary but as a secondary developmental process.

The starting-point of a comparison with the organization of the Trematodes, from which all authors agree that the Cestodes have been derived, is to be furnished not by the proglottis but by the entire Cestode, and, moreover, not as a chain of segments, but in its simplest form, as represented by the genus *Caryophyllæus*, as an unsegmented worm resembling the genera *Amphilina* and *Amphiptyches*, which are to be regarded as connecting-links between the Trematodes and Cestodes. The unisegmental Cestode with a single set of genital organs was the primeval form, from which, by means of further and fuller adaptation to the favourable conditions of nourishment and growth in the interior of the alimentary canal, the segmental Cestodes, with progressive individualization of the joints repeating themselves by growth in the longitudinal axis, have only secondarily been developed. Next to the Caryophyllidæ come the Ligulidæ, in whose ribbon-like body the generative organs indeed are metamerically repeated, though there is no corresponding outward segmentation; following these we have the Bothriocephalidæ, with short but sharply defined joints, which, however, are not yet set free as separate units, but are liberated from the body of the Cestode in larger sections after the sexual organs have arrived at maturity. A higher stage of individualization is reached in the Tæniadæ, where the proglottids are set free singly; and, lastly, the highest stage of all is attained in the case of many Phyllobothridæ, the joints of which undergo a further development after separation, with considerable increase in size, and are capable of independent existence for some time (*Echinobothrium*).

In spite of the similarity which exists between the alternation of generations in the Cestodes and that in the Acalephæ (Scyphomedusæ), a similarity so complete that the same term "strobila" is applied to the segmented stage in both cases, the origin of it in each case requires a very different explanation. The alternation of generations in the Scyphomedusæ, which are asexually produced as sections of a polype which segments and forms the strobila, appears, as compared with the simple direct development of certain Medusæ (*Pelagia noctiluca*), to be a primeval developmental process of palingenetic importance. Accordingly the *ephyra*, which is set free by fission at the distal end of the strobila, represents when contrasted with the young polype the morphologically higher and more perfectly organized form. The exceptional case of direct development, which is found in *Pelagia noctiluca* owing to omission of the strobila-stage, is to be regarded, on the other hand, as an entirely secondary condition, derived from the alternation of generations by a shortening of the developmental process.

In contradistinction to the Medusa set free at the distal end of the Acalephæ-strobila, the proglottis liberated from the Cestode-strobila represents, when compared with the ancestral Trematode, a lower form, simplified and to a certain extent retrograded by the disappearance of the organs of adhesion and of the alimentary canal, though in point of fact the reduction of the organs was a condition of its individualization. While in the former instance the alternation of generations is the original and primary process, and the completion of the metamorphosis in the same individual the later one, secondarily produced by shortening and simplifying the development, in the Cestodes exactly the opposite is the case, and the alternation of generations is the later form of development, secondarily derived from the metamorphosis which was formerly undergone by one and the same individual, in connexion with the simplification of the organization and the more favourable conditions of nourishment and growth owing to intestinal parasitism. It follows that we have to define the development of the Acalephæ as alternation of generations *, which in certain cases can be simplified by shortening into metamorphosis, while we must interpret the development of the Cestodes, on the other hand, as *metamorphosis, which, owing to individualization of certain products of growth, can give rise to variously complicated forms of alternation of generations.*

However, we have not yet taken into account the first most variable series of manifold and complicated developmental stages, by which the embryo produced from the fertilized ovum is transformed into the scolex. But it is precisely this portion of the ontogeny which is of peculiar importance for our problem, not only because by the appearance of a stage capable of asexual reproduction, and therefore distinguished as the primary nurse-form, the complication of the developmental processes interpreted as an alternation of generations is increased and the justice of such an interpretation thereby strengthened, but also because it is just this section of the development which is to be brought into direct comparison with that of the Trematodes. And if we are right in tracing the phylogeny of the Cestodes from the Trematodes, the development of the latter, which for a long time was itself considered as alternation of generations, must be repeated, though in a modified form, in their descendants.

Every one is aware that the digenetic Trematodes—and these alone, and not the monogenetic forms, can be considered in the comparison—as well as the Cestodes pass their immature stages in other hosts than those of the sexual animals, whereby a change of hosts becomes a necessity. In the case of the former it is usually a mollusk or other Invertebrate in whose body the intermediate generations develop themselves as the so-called "sporocysts" or "rediæ," according as they do or do not possess a mouth and alimentary canal, together with their progeny, the "Cercariæ" or Distoma-larvæ. In the case of the Cestoda, too, the part of first host is sometimes played by an Invertebrate, but generally it is a Vertebrate in which the young forms are to be found as "Cysticercoids" or

* It is owing to the astonishing similarity existing between the phenomena of growth and fission in the Acalephæ- and Cestode-strobilas, and between the formation of ephyræ and proglottids, that the phylogenetic contrast has been overlooked and the morphological value of the sexual generations in both cases identified, and that the mistake has then been made (Götte) of not admitting the development of the Acalephæ to be an instance of alternation of generations, but interpreting it as a metamorphosis.

"Cysticerci"—the latter usually encysting in parenchymatous organs. There can therefore be no question but that we must trace back Cysticercus as well as Cysticercoid either to the Cercaria-producing redia or sporocyst, or else to the Cercariæ themselves, provided that we admit the origin of the Cestodes from the Trematodes.

The choice between the two alternatives appears at first sight to be by no means an easy one; but, taking into consideration the analogy of the proliferation of the Cysticercus, it would seem to rest with the redia or sporocyst as the equivalent of the latter. However, a closer comparison shows us that in this proliferation we have to deal merely with analogous and not with homologous processes, since the germs produced by the sporocysts and rediæ, which were formerly regarded as spores, or even as internal buds, cannot be placed on the same level as the buds on the wall of the Cysticercus-vesicle, but must be considered as formations of quite a different kind. It is true that for a long time (that is to say as long as the theory that the Distoma-development was a case of alternation of generations remained undisputed) these formations were regarded as products of an asexual reproduction, that is as spores or buds, until the discovery of pædogenesis in Diptera-larvæ, and the precocious separation of the first sexual cells, which sometimes even takes place during the segmentation of the oosperm *, led to an entirely different view—a view which, supported by the consideration that spore-formation in Metazoa is *à priori* highly improbable, has now come to be the one which is generally accepted. In accordance with this view the so-called germ-cells in the sporocysts and rediæ are considered to be ovarian cells separated early and developing in the body of the larva; that is to say, they are held to be ova developing parthenogenetically †, and the development of a Distoma is no longer explained as a case of alternation of generations, but as a form of *heterogamy*. The sporocysts and rediæ would then be explained simply as larval forms which have undergone a retrogressive metamorphosis or else have been checked in their development for the purpose of aiding the rapid and extensive reproduction of individuals; they would correspond to larval

* Compare C. Grobben, "Die Entwicklungsgeschichte der *Moina rectirostris*," Arbeiten aus dem Zoologischen Institute in Wien und der Zoologischen Station in Triest: Vienna, 1879, Bd. ii.

† This interpretation, first given by Grobben (*loc. cit.*), has since been repeated by other investigators also in a precisely similar way, and may be said to have met with pretty general acceptance at the present day. *Cf.* also H. Schauinsland's 'Beitrag zur Kenntniss der Embryonalentwickelung der Trematoden,' Jena, 1883.

forms left behind at various stages of development, and from a morphological standpoint would have to be regarded as simplified progeny-bearing Cercariæ. It follows that the Cercaria alone would figure as the equivalent of Cysticercoid or Cysticercus. Now, as a matter of fact, this larval form does afford an immediate and natural comparison with those developmental forms of the scolex which on a number of other grounds we are compelled to regard as the primary and original ones. These are the little Cysticercoids which inhabit the bodies of Invertebrates, and which have only become known comparatively lately. While authors were formerly inclined to derive the Cysticercoid from a Cysticercus, simplified and diminished in size, and so to regard it as a Cysticercus whose vesicle, owing to unfavourable soil, had shrunk up and degenerated into a little appendage scarcely capable of containing the body of the scolex, they will now, on the contrary, have to derive the Cysticercus-vesicle from the enlarged caudal appendage of the Cysticercoid, which has become inflated owing to the collection of an aqueous fluid, and to consider it as a secondary modification which has arisen from this and adapted itself to a parasitic existence in the body of a Vertebrate. That this view is actually the correct one, and that the Cysticercoid and not the Cysticercus represents the primary form, from which the other must be derived, is not only rendered probable at the outset by the simpler structure and smaller size of the former, as well as by its sojourn in the bodies of the phyletically older Invertebrates, but also by the surprising similarity of form existing between certain Cysticercoids and Cercariæ, which renders possible, strengthens, and confirms a direct homology between the two.

The Cysticercoid of *Arion empiricorum*, which was first described by Stein, being divided by a constriction into a body and a caudal appendage, at once reminds us of the Trematode-Cercaria. To a much greater extent is this agreement seen in *Archigetes Sieboldii*; this is a Caryophyllid allied to *Caryophyllæus* and occurring in Naidæ in a sexual scolex-stage. Leuckart * states that the creature consists "like the Cercaria, of a flattened oval body and a cylindrical tail, which is inserted in a pit-shaped depression at the posterior end," so that without closely examining it one would suppose it to be a Cercaria. Not less striking is the resemblance of the Cysticercoid inhabiting the dog-louse and the

* Rud. Leuckart, "*Archigetes Sieboldii*, eine geschlechtsreife Cestodenamme, Zeitschrift für w. Zoologie, Supplementband, 1878, Bd. xxx.

flea, from which *Tænia elliptica* (=*cucumerina*) of the human intestine is derived.

It is only recently that we have received full details concerning this larval form and its caudal appendage, through the observations of Grassi and Rovelli *. Both of these authors recognized the soundness of the homology of body and tail-portion with the corresponding parts of the Cercaria, though they perhaps went too far in interpreting the anterior invagination of the Cysticercoid as the equivalent of the buccal cavity, the rostellum as the everted pharyngeal bulb, and the body-cavity without sufficient basis as the commencement of the mid-gut.

In correspondence with this comparison we also have the apparent agreement between the development of the Cercaria-tail and that of the caudal portion of the Cysticercoid, which, moreover, with reference to the position of the embryonic hooks, had been regarded as the enlarged body of the hexacanth embryo, and accordingly styled "head-maker" (*Kopfbildner*), and explained as nurse of the presumably subsequently formed scolex. As a matter of fact, however, it by no means represents the whole of the body of the embryo, but only the smaller portion thereof, from which, just as in the case of the cells budded off from the inner surface of the Redia to form the Cercaria, a broader section is differentiated as body and a narrower one as caudal appendage †. But this establishes beyond a doubt the value as individuals of the Cysticercoid and of the Cysticercus which is to be derived from it, in opposition to that view which would see in the Cysticercus a colony composed of at least two individuals, namely of the embryo, metamorphosed into the caudal appendage, or, rather, vesicle-wall, of the Cysticercus, and of the Cestode-head or scolex subsequently produced from this by budding.

The changes experienced by the Trematode-larva in its transition to the Cestode-larva also affect, in correlation to the atrophy of the alimentary canal and the consequent

* "Embryologische Forschungen von Prof. Battista Grassi und Dr. Giuseppe Rovelli," Centralblatt für Bacteriologie u. Parasitenkunde, Cassel, 1889, v. Band, no. 11.

† Grassi's observations on the development of the Cysticercoids of *Tænia elliptica* and *murina* have proved this deduction to be well founded; but in direct contrast thereto Villot regards the caudal appendage of the Cysticercoids as a new formation which has arisen from the embryo by budding. He does not, however, establish his contention, which is also directly opposed to the older view of the caudal appendage as the body of the embryo. Villot, "Mémoire sur les Cysticerques des Ténias," Annales de Sc. Nat. 1883, Tom. xv.

simplification of the organization, the anterior section of the body armed with its suckers and chitinous hooks, which was at an early period invaginated into the posterior portion and surrounded by this as by a protecting envelope. The evident necessity for protection, which was to a certain extent satisfied by this process, may also have determined the change of function of the tail, which from an organ for effecting the change of locality was transformed into a larger or smaller vesicle, accommodating the whole of the scolex inside itself; or again—and in all those cases in which the simple invagination of the scolex-head into the scolex-body gave a sufficient protection—degenerated into an apparently functionless rudiment, in order in the end to drop off entirely (*Bothriocephalus*). In the first case, however, in which the tail became a large vesicle filled with watery fluid, its great increase in size enabled it to acquire yet another important function—*proliferation*—and to produce by budding numerous scolices (*Cœnurus*), in some cases brood-capsules with scolices, either directly or by means of a second and third generation of vesicles (*Echinococcus*). While the metamorphosis was simplified in one direction, in the case of degeneration and shedding of the caudal appendage, into a more direct development, in the other it grew more complicated and assumed various forms of alternation of generations. In the latter, to a certain extent by way of compensation for diminished productiveness, owing to the loss of pædogenesis, the necessity for increasing the race was satisfied in a *newly acquired* way, namely by means of budding on the enlarged surface of the vesicle.

The power of proliferation, which has been only secondarily acquired by certain Cysticerci (*Cœnuri* and *Echinococci*), was, like the process of proglottid-forming by the strobila, wrongly used as a standpoint from which to interpret the whole Cestode development. From this point of view the scolex was regarded as the gemmation-product of the embryo, the proglottis as that of the scolex, and, in accordance with the interpretation of the individualized joints of the Cestode as sexual animals, the complicated five-jointed scheme of the *Cestode-metagenesis* was set up. In this arrangement the embryo figured as primary nurse-form, the scolex as nurse, and the proglottis as sexual individual, while the Cysticercus- and Strobila-stages, which furnish the connexion between primary nurse-form and nurse, and between nurse and sexual individual, were regarded as polymorphic colonies.

Thus then the metamorphosis of the parasitic Platyhelminthes led in the case of the Trematodes, owing to the pædogenesis of the larval forms known as Sporocysts and Rediæ, to a heterogamy which was for a long time believed to be alternation of generations; in the case of the Cestodes, on the other hand, it produced, owing to individualization of gemmation and fission-products of certain developmental stages, various more or less complicated forms of alternation of generations, the modifications of which receive their natural explanation and interpretation in the present *résumé.*

Both the budding on the wall of the Cysticercus-vesicle and the constriction and liberation of segments of the strobila are already foreshadowed in the development of the Distomæ—the former in the budding-power possessed by certain sporocysts (*Leucochloridium*), and the latter in the regular separation between the body and tail of the Cercaria and in the fission-phenomena presented by certain sporocysts (*e. g.* those of *Cercaria minuta*) and rediæ (those of *Cercaria echinata* and *fulvopunctata*). The caudal appendage also, the primary function of which is that of a motile organ, is to be regarded as a portion of the body which is capable of individualization. This results from the surprising discovery made many years ago by Alex. Pagenstecher * in the case of *Bucephalus*, and only recently confirmed and also established in many other cases by Ercolani †, that the tail is capable of transforming itself into a brood-producing fragment—that is, as it were, into a sporocyst. This process also elucidates the contrast between the caudal appendage of the Cysticercoid and the Cysticercus-vesicle and the invaginated neck or body of the scolex, exhibiting the latter in the light of a further section of the body of the worm, which, before the formation of proglottids sets in, perhaps regularly separates itself from the foremost portion representing the true head, and morphologically is by no means so very different from the tail.

Presuming it to be a legitimate and well-grounded assumption, owing to the *ensemble* of the facts, that just as the innumerable parasitic Copepoda, which present such manifold variations and often such grotesque shapes, have been developed from free-swimming Crustacea, so also the intestinal worms, through adaptation to a parasitic mode of life and the conditions of existence modified thereby, have arisen from free-living worm-forms; then, with regard to the Platyhelminthes, no doubt can exist that it was the Planarians—so closely allied to the Trematodes—to which they owe their

* Alex. Pagenstecher, "Trematodenlarven und Trematoden" (with six plates), Helminthologischer Beitrag: Heidelberg, 1857.

† G. B. Ercolani, 'Nuove ricerche sulla storia genetica dei Trematodi,' Tom. i. 1881, and Tom. ii. 1882.

origin. As the Dendrocœle Turbellaria of fresh and salt water exchanged a free existence for a parasitic one and adapted bodily form and structure to the new conditions of life—losing the outer covering of cilia (with the exception of the vestige still remaining during larval existence), while they acquired suckers and organs of adhesion of various kinds —they became Trematodes, which, in connexion with the easier and more favourable nourishment in the body of a host, acquired the power of producing a far more numerous progeny.

The closer representation of these processes becomes more complicated and difficult owing to the fact that in the case of so large a number of Trematodes, and practically universally among the Distomæ, with which we are especially concerned, we have *two different hosts* between which the life-history of the species is distributed. The one functions to a certain extent as intermediate host, and brings the intruding parasite only up to a certain stage of development; it conceals in its body the larval form, though even at this stage it may be capable of reproduction. The second host receives the parasite, which has reached it either actively or passively, and brings it to full development and sexual maturity; it harbours the sexual form. Now are the intermediate hosts —and this is a question which has already been sagaciously propounded by Rud. Leuckart*—" merely later intruders into the life-history of the Helminthes," or are they " the original genuine hosts, which primitively brought their intestinal worms to sexual maturity, but were subsequently degraded to the position of intermediate hosts, owing to the fact that the life-history of their parasites, through further development and differentiation, has been spread over a larger number of stages?" The first case would, to make use of E. Hæckel's noteworthy expression, represent a *cœnogenetic*, the latter a *palingenetic* condition. In the former rediæ and sporocysts would be later developed forms (*i. e.* than the sexual stages), secondarily and cœnogenetically modified through adaptation; in the latter, on the other hand, they would represent earlier-existing, philetically older, and once sexual forms. Now when Rudolph Leuckart very emphatically selects the second alternative, pointing by way of justification to the fact that at the present time nearly all Entozoa live during the sexual stage in the bodies of Vertebrates, which are undoubtedly of later origin, it seems to me that he has not hit the right nail on the head. Apart from the fact that fish and other aquatic

* Rud. Leuckart, 'Die Parasiten des Menschen,' part 2, Bd. i. p. 148.

Vertebrata were already in existence in Palæozoic times, and that for this reason alone the argument adduced loses its cogency, another circumstance seems to me sufficient to refute his view, at any rate as far as the Platyhelminthes are concerned. I refer to the remarkable agreement existing between Trematodes and Dendrocœle Turbellaria in the organization of the fully developed sexual forms, an agreement which, if the view in question were correct, could only be explained by means of a convergence of development, which is highly improbable, especially in view of the contrast between the conditions of life in the two cases.

At the same time, however, it by no means follows that we are bound to regard the intermediate hosts of the larval stages as only later intruders into the life-history of the Helminthes; far rather may we well maintain the notion that the young worms found their way into the bodies of Invertebrates at the very beginning of the phylogenetic process, but were there unable to arrive at full development and sexual maturity. On the other hand, owing to the altered conditions of subsistence, they underwent a necessary change of form, by virtue of which they, either themselves or in the persons of their pædogenetically-produced offspring, were enabled to leave their intermediate host once more by means of active or passive migration, and, being now transferred into the body of a Vertebrate under more favourable conditions of nourishment, they underwent in their new host, as the definite carrier of the sexual animal, their full morphological and digenetic-sexual development. In this manner the regular occurrence of an intermediate host in the life-history of the Helminthes and the distribution of the developmental phases between two (or more) hosts may find an unstrained explanation. It will also appear quite comprehensible that in the case of numerous intestinal worms not one single, but many *, generally

* Many of the intestinal worms appear to possess an especially great adaptability to the conditions of nourishment in the bodies of their hosts, which renders intelligible the occurrence of one and the same species of Entozoon in different and even widely distant hosts. For instance, *Distomum echinatum*, which is developed from the *Cercaria echinata* of various species of mollusks, is found sexually mature not only in the intestine of the duck and other waterfowl, but also in that of the dog, the rat, and the mouse. The *Cysticercus cellulosæ* of *Tænia solium* lives not only in the body of the pig, but also in the most dissimilar organs of the human subject, and has also been found in the muscles of the roe, the dog, and the cat. *Tænia elliptica* occurs not only in the intestine of the cat, but also (*cucumerina*) in that of the domestic dog and of man. We may further instance the distribution of *Echinococcus* and of numerous Nematodes, especially of *Trichina spiralis*, in the bodies of the most widely different mammals.

closely-allied species of animals are found as the intermediate hosts of the same species of worm, and that the same thing also recurs in the case of the hosts of the sexually mature Helminthes.

Now if as early as in the case of the Trematodes, which are phylogenetically to be derived from Dendrocœle Turbellaria, the intermediate hosts were not the original hosts of the sexual worms, much less can this have been the fact with regard to the Cestodes which have been developed from them; neither Cysticerci nor Cysticercoids in the bodies of their victims will ever have represented the terminal stages with digenetic reproduction in the life-history of these Helminthes. Like the larvæ of the Trematodes the young stages also of the oldest Cestodes, living in the intestines of fish and other aquatic Vertebrata, penetrated the bodies of Invertebrates, and there transformed themselves, instead of Rediæ and Cercariæ, into Cysticercoids.

It was only later on, with the appearance of birds and mammals, that the Tæniadæ came into existence, the larval stages of which remained only to a limited extent in Invertebrates, but in the majority of cases migrated into the bodies of Vertebrata, in which from Cysticercoids they developed into Cysticerci. The reader will be reminded by these observations of the doctrine of von Siebold, who regarded the Cysticerci as tapeworms gone astray into the wrong animals, becoming in a strange abode dropsical and degenerate, whereby he for a long time denied the value of the Cysticerci as normal larval stages of Cestodes. As a matter of fact we might just as well speak of going astray in the case of phylogenetic development as in that of free-living animals, certain individuals of which are cast away beyond the limits of distribution of the species into domains far distant and separated by mighty barriers, and there, as a result of the entirely altered conditions of subsistence, give rise to the development of new species and groups. And since in physiology no hard-and-fast line is to be drawn between the normal and the pathological, and only so far in theory, as the latter processes bring with them disturbing results *detrimental to the life of the individual*, we should even hold the conception of the dropsical degeneration to be justified *, though certainly in a sense very different from that of Siebold's doctrine, which was entirely opposed to the idea of transmutation, and, as compared with the results of Kuchenmeister and R. Leuckart's investigations, merely defended an *error*. It is therefore a serious and

* C. Claus, 'Grundzüge der Zoologie,' 4th edition, part ii. 1879, p. 389.

scarcely intelligible exaggeration when E. Hæckel *, who criticises the phylogenetic relations of the Cestodes in a similar manner, vindicates the merits of von Siebold in having been the first to discover the true explanation and point out the way by which we may be enabled to understand the causes of the ontogenetic phenomena.

Up to the present only a single exceptional case has become known of a Cestode already sexually mature in the Cysticercoid state. I allude to the parasite from the body-cavity of the Naidæ, described by its discoverer, Ratzel, as *Caryophyllæus appendiculatus*, but which was first shown by Rud. Leuckart to be fully sexual and capable of reproduction, and constituted by him the representative of a special genus *Archigetes*. Although this exceptional case appeared to afford a yet firmer basis to the hypothesis of the renowned helminthologist, that the larval stages living in the intermediate hosts were originally the sexual forms, it should nevertheless be far more natural, in view of the relations which we have discussed, to recognize in this case no exceptional survival of a primitive condition, but to interpret it in the light of a secondary transference of sexual maturity to the larval state, just as encysted larval stages of Trematodes (*Gasterostomum gracilescens* in cysts of *Gadus* and *Distomum agamos* of the Gammarinæ) may also become sexually mature.

The designation *Archigetes* ("ancestor") bestowed by Rud. Leuckart on the parasite of *Sænuris* as the result of his interpretation of it, would apply to our divergent interpretation also, in so far as we have in *Archigetes* a Caryophyllid devoid of the power of proglottid-formation and with simple sexual organs. In this sense, however, it would meet with our approval the more unreservedly, as with it not only may the view of the unsegmented Cestode—in contradistinction to the proglottis—as the equivalent of the Trematode be confirmed, but also, as a further result, the attempted derivation of the Cestode-body in the foregoing exposition may be completely justified. Moreover, in our at present imperfect knowledge of the development of *Archigetes* the possibility appears by no means excluded that this interesting parasite also possesses its *Caryophyllæus*-stage in the intestine of fish, and only under certain conditions attains to degenetic maturity in the body of Naidæ. We may have here a similar dimorphism to that with which Zeller's excellent work has made us acquainted in the case of *Polystomum integerrimum*, with its two sexually mature forms—the one on the gills of the tadpole, the other in the urinary bladder of the frog.

* E. Hæckel, 'Metagenesis und Hypogenesis von *Aurelia aurita*,' Jena, 1881, p. 33.

LII.—*Notes on some Ganoid Fishes from the English Lower Lias.* By A. Smith Woodward, F.G.S., F.Z.S., of the British Museum (Natural History).

[Plate XVI.]

The accumulated discoveries of many years, preserved in several Museums, afford the opportunity for a revision of our knowledge of the Fish-fauna of the English Lower Lias, and also make known a few interesting forms as yet unrecognized. Having had frequent opportunities of pursuing the subject during the last few years, the writer ventures to offer the following remarks on some of these new and little-known fishes—the result of observations chiefly based on specimens in the British Museum.

I. Family **Palæoniscidæ.**

As already remarked by Traquair *, the Palæoniscidæ of the Lias comprise the four fishes described by Egerton under the names of *Oxygnathus ornatus*, *Cosmolepis Egertoni*, *Thrissonotus Colei*, and *Centrolepis asper*. A fifth genus and species, *Lissolepis serratus* of Davis, is also described as referable to the same family; but there seems to be no justification for this determination, and the fish in question has lately been removed to the Eugnathidæ †.

Genus Centrolepis.

Of the undoubted Palæoniscidæ the genus *Centrolepis* is the most striking and well characterized. It is, however, very rare, there being only three specimens in the British Museum; and the caudal pedicle and fins still remain unknown. The new examples show that the type species, *Centrolepis asper*, is not so short and stout as supposed by Egerton; the fin described as anal being truly one of the pelvic pair, while the marginal rays ascribed to the lower lobe of the caudal fin are undoubtedly those of the anal. Moreover, the scales described and figured in the original notice are all referable to the ventral aspect, those of the flank (Pl. XVI. fig. 1) being somewhat deeper in proportion to their

* R. H. Traquair, "Ganoid Fishes of the British Carboniferous Formations," pt. i. (Pal. Soc., 1877), p. 12.

† Woodward and Sherborn, "Catalogue of British Fossil Vertebrata" (1890), p. 77. Complete references to the literature of the subject under consideration will be found in this work.

width, and with less radiating markings. In short, the more important known facts in the skeletal anatomy of this fish may now be summarized as follows:—

Trunk fusiform, robust, and somewhat elongated. Mandibular suspensorium oblique; dentition consisting of an inner series of large conical teeth, well spaced but numerous, and an outer close series of smaller teeth, similar in form; head, opercular, and branchiostegal bones externally tuberculated or rugose. Fins large, consisting of broad, flattened rays, all articulated and distally bifurcating, more or less coated with ganoine; anterior borders fringed with well-developed fulcra. Dorsal and anal fins triangular in shape, elevated, the dorsal opposed to the space between the pelvic fins and the anal. Scales thick, of moderate size, and highly ornamented; not much deeper than broad upon the middle of the flank, as deep as broad on the ventral aspect. Each scale of the abdominal region marked in its hinder half by coarse postero-inferiorly directed ridges and sharp denticulations, in its anterior half by few, irregular, more or less interrupted vertical ridges and furrows; the scales of the caudal region coarsely serrated posteriorly, with a few short, transverse sculpturings anteriorly.

Genus Oxygnathus.

The facts made known in Egerton's description of *Oxygnathus* suffice to demonstrate the right of the type species to generic distinction, although the "diagnosis" is as unsatisfactory as most of those in early palæichthyological writings. The figure (Egerton's pl. ix.), however, exhibits some inaccuracies, the pectoral fin-rays being unarticulated except at the extremities, as correctly noted in the description; the striations upon the jaws not being regular parallel lines, but short and wavy fine ridges, irregularly anastomosing and bifurcating; while the supposed indications of "ossified vertebræ" are either small pleurocentra and hypocentra, or, as seems more probable, merely the expanded bases of the arches.

A new diagnosis of the genus, based upon the original description and the examination of the large series of examples in the British Museum, may thus be enunciated in the following terms:—

Trunk elegantly fusiform, more or less elongated. Mandibular suspensorium oblique; dentition consisting of a series of large, well-spaced conical teeth, and numerous minute teeth irregularly arranged and somewhat clustered; cranial roof-bones finely tuberculated, sometimes rugose, the facial bones and branchiostegal rays delicately striated, and the opercular bones almost smooth. Fins of moderate size or small, the rays broad, distally bifurcating, and more or less covered with a very thin layer of ganoine; the rays of the pectoral fins, except the few short ones placed hindermost, articulated only at the distal extremities, all others uniformly articulated to the base; fulcra minute or absent. Dorsal and anal fins triangular in shape, somewhat longer than high, and the hinder rays very short; dorsal opposed to the space between the pelvic and anal fins; upper caudal lobe narrow and much attenuated, with small ridge-scales, the fin deeply forked and symmetrical. Scales thick, small, or of moderate size, very narrow ventrally, and ornamented with delicate, oblique lines of ganoine, in part bifurcating and branching, becoming very faint upon the anterior dorso-lateral region and partly subdivided into tubercles.

The only character of generic value in *Oxygnathus ornatus* that still remains doubtful is the relative length of the anal fin, no known specimen exhibiting this appendage so satisfactorily as desirable. That it will prove to be elongated, however, seems evident from the fact that in every other generic character the so-called *Cosmolepis Egertoni* is identical with *Oxygnathus*, and the elongation of the anal fin is distinct in the type specimen of that fish. Moreover, the so-called *Thrissonotus Colei* is not separated from *Oxygnathus ornatus* even by specific characters, and in this case the anal fin is again distinctly elongated. This fish owes the peculiarities of its squamation entirely to the fact that it occurs in a very hard nodule, which has split in such a manner as to destroy the superficial scale-ornament, and exhibit the structural lines of growth. All the ordinary specimens of *Oxygnathus ornatus* occur in the well-known soft Lias clay, and thus exhibit the superficial ornamentation more or less intact.

To the synonymy of *Oxygnathus ornatus* the present writer would thus relegate the so-called *Thrissonotus Colei*, the species being as yet known only from the Lower Lias of Lyme Regis; and the more deeply fusiform species, hitherto named "*Cosmolepis*," may be termed *Oxygnathus Egertoni*, this being at present peculiar to the Lower Lias of Barrow-on-Soar.

Genus Coccolepis.

Three imperfectly preserved specimens in the British Museum indicate the occurrence of a new small Palæoniscid fish in the Lower Lias of Lyme Regis; two of these specimens being tolerably complete, but the third wanting the head and the greater part of the abdominal region, while apparently shortened by accidental crushing. The principal characters of the genus and species are shown in the accompanying Pl. XVI. figs. 2–4.

The maximum depth of the trunk is contained about four and a half times in the total length, which does not exceed 0·135. The *head* (Pl. XVI. figs. 2, 3) is longer than deep, it and the opercular apparatus together being comprised about four and a half times in the total length. The orbit is large and far forwards, and the snout projects somewhat in advance of the mouth. The mandibular suspensorium is very oblique and the jaws are slender, with a wide gape. The mandible is pointed at the symphysis and bears two rows of teeth, the inner series consisting of large, regular, well-spaced, conical teeth, somewhat curved, and the outer series comprising numerous closely arranged minute teeth. The dentition of the upper jaw is smaller than that of the lower, though the inner row is similar in character and the outer row is not clearly recognizable. The cranial and facial bones are ornamented with coarse rounded tuberculations, which are rarely elongated and fused into short rugæ; and these tuberculations become more sparse on the operculum and suboperculum. The operculum (fig. 3, *op.*) is much smaller than the suboperculum, and the latter element is deeper than broad.

The vacant space occupied by the *notochord* is distinct in the original of fig. 2, and there are no undoubted ossifications in the notochordal sheath. In the abdominal region there are not less than twenty-eight segments, represented by well-developed neural arches and relatively minute hæmal cartilages. Each of the neural arches is robust, but elongated, much expanded at its base, less expanded distally, and bearing a long, slender, neural spine, which is merely apposed and not in direct connexion; the representatives of the hæmal arches are merely small expansions, each with a vertical ridge. In the caudal region both the neural and hæmal arches are complete and apparently more ossified than those of the abdominal region; the arches are all short and robust, and in each case the spine is evidently directly fused with its supporting pedicles. At the inferior lobe of the caudal fin the hæmal spines become expanded for the support of the dermal rays, and at the base of the upper lobe there is a series of interspinous bones supporting the large fulcral scales.

All the *fins* are made known in the specimens under consideration. The pectoral fins are not excessively large, and all the rays are articulated at distant intervals. The pelvic fins also consist of robust articulated rays, are situated nearer to the anal than to the pectorals, and are not much inferior in size to the latter; their height seems to be greater than the length of their base-line. The more anterior rays of the dorsal and anal fins and the lower lobe of the caudal are especially robust and covered with ganoine, and fulcra are only distinctly observed on the caudal. The dorsal fin arises at the middle point of the back, opposite the hinder half of the pelvic fins, and is elevated and triangular-acuminate in shape, the length of its base-line not exceeding its height. The anal fin is relatively small and low, its height equalling only half that of the dorsal, and its length being only about three quarters that of the latter. The caudal fin is deeply forked and not quite symmetrical, the much attenuated upper lobe being somewhat larger than the lower.

The *scales* are small and thin, and the proportions of those of the abdominal region are well shown in the original of Pl. XVI. fig. 2. They are not deepened upon the flank, and, as shown by no. 39865 (Pl. XVI. figs. 4, 4 *a*), the external ornament consists of numerous rounded tuberculations of ganoine. They appear as if rounded posteriorly and overlapping. The fulcral scales of the upper caudal lobe are very large, with slight longitudinal sculpturings.

Determination.—On selecting from the characters thus detailed those that seem to be of generic value it will be observed that the fish approaches most closely the small round-scaled Palæoniscid *Coccolepis* *, from the Lithographic Stone of Bavaria. Judging from the elaborate description of the latter genus by Vetter †, the new Liassic species exhibits only one essential difference from the typical form, namely the articulation of the pectoral fin-rays. These rays, however, have only been partially seen in a single example of *Coccolepis Bucklandi*; and, as it is sometimes difficult to recognize the delicate transverse sutural lines even in well-preserved examples, we venture to place the Liassic fish in the same genus until more satisfactory specimens of the type species are discovered. The Rev. W. R. Andrews, F.G.S., has presented to the Museum of Practical Geology a species of *Coccolepis* from the Purbeck Beds of the Vale of Wardour ‡, but this has not yet been described; and *C. Bucklandi* thus remains the sole representative of the genus bearing a defined

* L. Agassiz, Rech. Poiss. Foss. vol. ii. pt. i. (1843), p. 300.

† B. Vetter, "Die Fische aus dem lithographischen Schiefer," Mittheil. k. min.-geol. Mus. Dresden, pt. iv. (1881), p. 37, pl. i. fig. 2.

‡ Woodward and Sherborn, *op. cit.* p. 37.

specific name. From this the fish now made known is distinguished by the more remote situation and relatively smaller size of the dorsal fin, and probably by less conspicuous characters at present imperfectly revealed. The name of *Coccolepis liassicus* is thus proposed for the new species, in reference to its stratigraphical position.

II. Family **Cœlacanthidæ.**

Genus Undina.

Well-preserved examples of a large Cœlacanth Ganoid (*Holophagus gulo*) have already been described by Egerton and Huxley from the Lower Lias of Lyme Regis; but no member of the same family has hitherto been detected in a corresponding horizon elsewhere. The British Museum, however, now furnishes evidence of a distinct species from the Lower Lias of Barrow-on-Soar, Leicestershire; and, although the specimen is not so satisfactorily preserved as desirable, it exhibits several features specially worthy of note in comparison with the Cœlacanths both of earlier and later date. The fossil occurs on counterpart slabs, and one is shown, of the natural size, in Pl. XVI. fig. 5.

The head and the greater portion of the trunk are exhibited from the lateral aspect, the anal and paired fins only being entirely wanting. The head and opercular bones, so far as preserved, do not exhibit any external ornamentation, though some rounded pittings in an impression of the operculum may possibly indicate the presence of a few large rounded tubercles upon that bone. Above the orbit a series of small quadrangular plates (x) may be either parafrontals or sclerotics; and one of the pterygo-quadrate elements (*ptq.*) is seen, with obscure traces of small conical teeth. The impression of the inner aspect of one of the jugular plates (*ju.*) is also distinct, proving that bone to have been narrow and elongated, nearly four times as long as its maximum width. The first dorsal fin (d^1) exhibits not less than seven very long stout rays, articulated in the distal half, and the anterior margin of the first ray is fringed by well-developed upwardly-pointing denticles*. The second dorsal (d^2), though much broken, is evidently smaller than the first and consists of very slender rays. The hinder half of the caudal region is displaced, almost severed from the rest of the fish, and partly destroyed. Sixteen rays can be distinctly counted in the

* These denticles are scarcely seen on the slab figured, but are distinct on the counterpart.

upper half of the principal caudal fin (*c*), these rays being articulated, though not expanded, distally; and there are remains of a well-developed supplementary caudal fin (*sc*). The squamation is only preserved in the anterior half of the abdominal region and at the base of the supplementary caudal fin, each scale being ornamented with four to six large elongated tubercles, irregularly arranged in an antero-posterior direction, and sometimes subdivided transversely (fig. 5 *a*).

Determination.—The fish thus described is closely similar in proportions and in the character of its fin-rays to the typical *Cœlacanthus*; but it is generically distinguished by the presence of denticles upon the first dorsal fin and by the scale-ornament. With the Jurassic genus *Undina* *, however, it agrees in every essential particular except the non-expansion and comparatively sparse articulation of the distal half of the fin-rays; and as these characters are of doubtful value, it seems advisable, at least provisionally, to place the Barrow species in the well-known genus just mentioned. To the present writer it appears that no sufficient generic difference has yet been pointed out between the so-called *Holophagus* and *Undina*; but the new fossil now described is distinguished both from the Lyme Regis fish and the typical species of the Bavarian Lithographic Stone by the characters of the fin-rays and scales and by the comparative fewness of the caudal fin-rays. The specimen may thus be regarded as indicating a hitherto unknown species, for which the name of *Undina barroviensis* will be appropriate.

EXPLANATION OF PLATE XVI.

Fig. 1. *Centrolepis asper*, Egerton. Scales of flank, twice nat. size. Lower Lias, Lyme Regis. [B. M., no. P. 5594.]

Fig. 2. *Coccolepis liassicus*, sp. nov. Lateral aspect of fish. *Ibid.* [B. M., no. P. 887.]

Fig. 3. Ditto. Head, lateral aspect, twice nat. size. *Ibid.* [B. M., no. P. 6153.] *br.*, branchiostegal rays; *md.*, mandible; *mx.*, maxilla; *orb.*, orbit; *op.*, operculum; *pct.*, pectoral fin.

Fig. 4. Ditto. Caudal region, lateral aspect. *Ibid.* [B. M., no. 39865.]

Fig. 4 *a*. Scale of ditto, three times nat. size.

Fig. 5. *Undina barroviensis*, sp. nov. Lateral aspect of fish. Lower Lias, Barrow-on-Soar. [B. M., nos. 21335, P. 3343.] *c*, principal caudal fin; d^1, d^2, first and second dorsal fins; *ju.*, jugular plate; *ptq.*, pterygo-quadrate bone; *sc*, supplementary caudal fin; *x*, parafrontal (? or sclerotic) plates.

Fig. 5 *a*. Scales of ditto, three times nat. size.

[B. M. = British Museum. Unless otherwise stated the figures are of the natural size.]

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* G. von Münster, Neues Jahrb. 1834, p. 539, and Beitr. Petrefakt. pt. v. (1842), p. 57.

LIII.—*Description of a new Genus and Species* (Parymenopus Davisoni) *of Mantodea from the Oriental Region.* By J. Wood-Mason, Superintendent of the Indian Museum, and Professor of Comparative Anatomy in the Medical College of Bengal, Calcutta.

[Plate XVII. A.]

A unique specimen of the interesting Orthopterous insect described below is contained in a small collection of Mantodea which has recently been sent to me for determination by Mr. William Davison, Curator of the Raffles Museum, Singapore, after whom I have much pleasure in naming the species.

Parymenopus*, gen. nov.

♀. Allied to *Hymenopus*, Serville. Eyes less produced and devoid of non-faceted corneal spines, of which not a vestige remains.

Median lobe of vertex not produced into a horn, its anterior end terminating in a slightly excavated isosceles-triangular vertical area, which answers to the fluted front face of the frontal horn in the allied genus.

Pronotum oval, narrower, granulated on the disk, distinctly toothed at the sides, with a moderate constriction near the hinder end.

Organs of flight shorter. Tegmina with the first branch of the anterior ulnar vein only 2-branched, the v. plicata 4-branched. Wings with the outer half of the anterior margin and of the veins of the anterior area distinctly arched.

Legs all identically the same in general form and structure; the fore legs exactly the same; the four posterior legs with the inferior foliaceous crests of the femora moderate, at their widest part hardly exceeding the greatest width of the joint, and with all the other crests simple and unexpanded.

Distribution. The Malayan subregion of the Oriental Region.

The absence of a frontal horn and of non-faceted corneal spines readily distinguishes the new genus from the old.

Parymenopus Davisoni, sp. n.

♀. Head Indian-yellow, unmarked. Pronotum distinctly

* From *παρά* and *Hymenopus*, generic name=*παρυμενόπους*=*Parymenopus*.

though rather sparsely granulated on the disk, not very coarsely denticulated on the sides, the denticles increasing in size and becoming truncated towards the constriction, where they cease; Indian-yellow, with the hinder border and a fine line therefrom forwards to a semicircular blotch in the middle of the hinder lobe, the bottom of the supra-coxal groove in the middle, and a V-shaped mark on the anterior lobe connected therewith, all dark brown; prosternum paler, with a regular crescent-shaped black-brown mark, the concavity of which is directed forwards, situated about midway between the insertion of the fore legs and the hinder margin, and extending right across the part so as to embrace the lower edges of the pronotum.

Abdomen pale testaceous, concolorous with the ventral surface of the thorax and the leg-bases, with a pair of fuscous spots near the posterior angles of terga 2–6 inclusive, and on sternum 7.

The organs of flight when closed extend by about one sixth of their length beyond the extremity of the abdomen.

Tegmina three times as long as broad, rather acutely pointed, oval; the marginal field coriaceous, opaque, cinnabar-red, the rest (except the membranous anal gusset, which is yellowish milky) semiopaque, yellow, with three opaque green radial spots, one small and roundish midway between the base and the stigma, and two about thrice as large and transversely elongated situated one at each end of the stigma; the stigma long, linear, concolorous with the wing-membrane, and placed upon the posterior radial vein at a distance from the base equal to twice its own length, apparently diffused over the veinlets of the cell immediately behind it; both v. dividens and 4-branched v. plicata anastomosed with the posterior ulnar vein, as in *Hymenopus bicornis*.

Wings somewhat more pointed even than the tegmina, semiopaque, greenish cream-coloured, with the outer half of the anterior margin and the apex semiopaque, reddish yellow, and with the outer margin of the anal area narrowly and decreasingly to the anal angle subhyaline, faintly tinged with fuscous of a vinous tint; the anterior ulnar vein emits only two branches, and its extremity is in correspondence with the extremities of the veins in front of it and with the anterior margin, distinctly arched.

Legs Indian-yellow, more or less flushed with red, but not barred. Fore tibiæ armed on the outside with 23 and on the inside with 17 teeth. Foliaceous lobes of the four posterior femora moderate, not more than 1·5 millim. wide in their widest part.

Total length 38 millim.; length of pronotum 8, breadth at dilatation 4·75; length of abdomen without seg. med. 17, breadth 8; length of tegmina 30, breadth 10·5, of marginal field 3; length of fore coxa 9·5, femur 11·3, of intermediate femur 7, tibia 5, of posterior femur 8, tibia 7.

♂. Unknown.

Hab. Singapore.

EXPLANATION OF PLATE XVII. A.

Parymenopus Davisoni. *a*, head and pronotum from above; *b*, head from in front; *c*, intermediate leg of the left side from above; all × 5. Camera lucida reductions of drawings made under a Ross's 4-inch by the aid of a camera lucida.

LIV.—*Description of* Triænocorypha Dohertii, *the type of a new Genus and Species of Mantodea.* By J. Wood-Mason, Superintendent of the Indian Museum, and Professor of Comparative Anatomy in the Medical College of Bengal, Calcutta.

[Plate XVII. B.]

Triænocorypha, gen. nov.

Head armed with three slender conical horns, two paired, arising posteriorly from the submedian lobes, and one unpaired, anteriorly from the middle of the anterior end of the median lobe of the vertex; facial shield transverse. Pronotum armed on each of its two lobes with a pair of spines similar to, but taller than, those which form the cephalic horns; its supracoxal dilatation prominently triangular. Postero-lateral angles and sides of the seven basal abdominal terga produced downwards and backwards into long, externally concave, and slightly curved spines, the longest of which is about two thirds, and the shortest about one third, as long as the fore femur. Fore femora lamellar, oval, about twice as long as broad, armed below on the outer edge with 4 spines, on the inner with 5, exclusive in each case of the spine of the apical lobe, and on the disk with 2 only, the first of which, answering to the basal one of the series in *Oxypilus* and its allies, is the larger, and the second, answering to the apical one of the series in the same genus, is much the smaller, the intermediate spines being absent; tibiæ armed below on the inner edge with 6 spines, and on the outer with 1 only—that immediately opposite to the insertion of the tarsus—the remainder of the series being represented by a just perceptible undulation of the edge; posterior femora furnished with a narrow, foliaceous, inferior carina; tibiæ broadly and shallowly constricted near the apex; first joint of the tarsi longer than all the rest taken together.

Founded on a very young larva.

Allied to *Oxypilus*, *Ceratomantis*, *Pachymantis*, and *Hestias*.

Distribution. Malayan subregion of the Oriental Region.

Triænocorypha Dohertii, sp. n.

Young larva. Dark sepia-brown, with a greyish-white stripe along the concave outer face of the 7 + 7 abdominal spines; two pairs of delicate filaments of uncertain nature at the extremity of the abdomen whity brown; the fore legs uniform pale clear vandyke-brown, and the posterior legs greyish white, marbled with dark sepia-brown.

Total length about 5·25 millim.

Hab. Perak, Malay Peninsula.

Captured by Mr. William Doherty, of Cincinnati, U.S.A., who has already furnished me with much valuable material for my 'Catalogue of the Mantodea,' and after whom I have hence much pleasure in naming this remarkable addition to the fauna of the Oriental Region.

EXPLANATION OF PLATE XVII. B.

a, head from in front; *b*, pronotum from the left side; *c*, left fore leg from the outside; *d*, abdomen from the left side: all × 18.

LV.—*Further Descriptions of Butterflies and Moths collected by Mr. F. J. Jackson in Eastern Africa.* By Emily Mary Sharpe.

I have now finished the arrangement of Mr. Jackson's first collection, and add descriptions of some new species. Until his return it will be impossible for me to give the exact localities where the species were collected; but it is certain that they were obtained *en route* from Mombasa to the Ulu Mountains, the bulk being probably from the last-named locality. I have again to acknowledge the kind assistance of Mr. Butler in determining this collection.

Fam. **Pieridæ.**

Teracolus eliza, sp. n.

Similar to *T. regina*, Trimen, but differs in having a black line commencing from the first median nervule, which continues to spread up to the costal nervure, this black line enclosing a large prismatic purple patch on the fore wing; the nervules on the hind wing terminate in rather large black spots on the hind margin; the black veins in *T. eliza* are strongly indicated; at the base of the wings there is a slight dusting of grey. Diam. 65 millim.

The female of *T. eliza* is somewhat like that of *T. regina* figured in Mr. Trimen's book (pl. xi. fig. 3), but differs in having a very broad black scalloped border on the hind margin of the hind wing. *T. eliza* has one black spot at the end of the discoidal cell; there is also another spot between the median and submedian nervules.

The underside of the female is pale yellow, with a stronger streak of dark yellow along the submedian nervure. There is also a row of black spots between each nervure. The basal half of costa is deep orange. Diam. 63 millim.

Teracolus laura, sp. n.

Similar to *T. subvenosus*, Butler, but differing in having a black line commencing from the submedian nervure and proceeding up to the costa, enclosing a patch of fiery orange-red at the apex of the fore wing. The black margin of the hind wing is broad and inclined to spread a little way up the nervules. *T. laura* has a black spot at the end of the discoidal cell on the fore wing, and there is also a faint spot on the hind wing at the end of the cell. The bases of the wings are thickly dusted with grey.

The nervules on the underside of *T. laura* are strongly marked with black, and there is also a faint border of a yellowish-green colour along the hind margin of the hind wing.

The female of *T. laura* differs from that of *T. subvenosus* in having no black spot at the end of the cell and also in having the outer edge of the dark basal area of the fore wing regularly angulated, like a flight of three steps. Diam. 47 millim.

Fam. **Acræidæ.**

Telchinia alicia, sp. n.

Similar to *T. bonasia*, Fabricius, of which Mr. Butler considers *T. serena* to be only the female. Both sexes are represented in Mr. Jackson's collection, and the male differs in the black marking on the hinder margin of the fore wing, which is continued from the basal area to nearly the middle of the inner margin. In *T. bonasia* the black basal area of the hind wing joins the black basal area of the fore wing, as in *T. alicia*, but it is continued upwards towards the disk of the latter, so that the orange of the fore wing is much narrowed towards the base of the wing.

The black border of the hind wing is much narrower in *T. alicia* than it is in *T. bonasia*, and the hind wing is also parti-coloured, the inner portion of the wing being ochreous as far as the third median nervule, the rest of the hind wing being deep orange, like the fore wing. The female differs in the greater width of the yellow areas on both sides. Diam. 38 millim.

Alæna johanna, sp. n.

Nearest to *A. interposita*, Butler. The wings above are of a smoky blackish-grey colour, with a line of white in the discoidal cell. There is a half-circle of white spots on the fore wing, placed between the subcostal nervules, commencing from the costal margin, and leaving a very broad band of smoky black along the hind margin, widening towards the apex; there is also a white patch below each median nervure, these white patches forming a continuous band with the subcostal spots before mentioned. The hind wing has a band of white from the inner margin extending to the first subcostal nervure, but narrowing somewhat as it approaches the latter. Fringe white, but black at the end of each nervule. Diam. 26 millim.

Lepidoptera Heterocera.

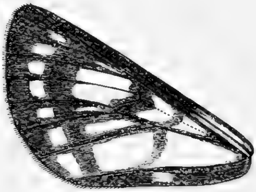
Fam. **Anaphidæ.**

Heteranaphe, gen. nov.

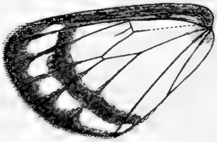
Similar to *Anaphe*, but distinguished by its huge and coarsely pectinated antennæ and by the neuration of the hind wing, the subcostal branches arising from the end of the cell instead of from a foot-stalk.

Heteranaphe Jacksoni, sp. n.

General colour yellowish white, with a blackish-brown border along the whole of the fore wing, this forming a broad band along the hind margin and widening towards the apex; a second band traverses the fore wing from the inner margin up to the costa. At a little distance from the marginal band and between the two broad bands of darkish brown is enclosed a row of yellowish-white spots, separated by the nervules, which are also darkish brown. There is a narrow bisinuated band across the basal third of the wing and a large reniform spot at the end of the discoidal cell.



The coloration of the hind wing is much more simple, being yellowish white, with two brown bands near the hind margin, one terminal and the other subterminal, enclosing a row of white spots forming a band, which is rather broader than in the fore wing.



Thorax black, with white hairs and a white patch on each side of the collar. Body black, banded with white; base of antennæ, mouth, and centre of ventral surface of abdomen tufted with orange; legs black; coxæ varied with orange hairs. Diam. 72 millim.

Fam. **Liparidæ.**

Leucoma macrocera, sp. n.

Entirely white, with a pearly gloss. Allied to *L. translucida*, Oberthür (Ann. Mus. Genov. vol. xv. p. 177, tav. i. fig. 6, 1880), but much larger, and distinguished by its large antennæ. Mr. Oberthür, in his description, mentions that his *L. translucida* is absolutely without spots; but in the figure there is a discoidal blackish spot. Diam. 44 millim.

LVI.—*On the Varieties of* Chalcides ocellatus, *Forsk.* By G. A. Boulenger.

Material recently added to the Collection of the Natural-History Museum enables me to extend my remarks on the forms of *Chalcides ocellatus.* In this widely distributed Scink the number of rows of scales varies from 24 to 40, an amount of variation which is to be found in no other lizard. Although a splitting up into several species appears to me unwarranted, I think it, however, necessary to recognize the several forms under special varietal names.

The following are the forms with which I am at present acquainted:—

A. Var. *Ragazzii.*

24 scales round the body. Greyish above, with an indistinct paler dorso-lateral band, but without spots except on the sacral region, hind limbs, and tail, which are ocellated as in the typical form; confluent black spots form a lateral band extending from the nostril to above the axilla, passing through the eye and above the ear-opening. From snout to vent 83 millim.

The only specimen examined was obtained at Assab by Dr. Ragazzi, and submitted to me for examination by the Marquis G. Doria.

B. Forma typica.

28–30 scales round the body. Olive or brown above, ocellated with black spots, sometimes confluent into irregular transverse bands, bearing central white dots or longitudinal shafts. Measures up to 140 millim. from snout to vent.

Ranges from the Algerian Sahara to Egypt, Syria, Cyprus, Arabia, Persia, and, according to J. A. Murray, to Sind.

C. Var. *tiligugu,* Gmel.

28–34 scales round the body (usually 30–32). Above olive or brown, with black and white ocelli, and a more or less distinct lighter lateral band, sometimes edged with black inferiorly. Stouter and larger than the preceding, reaching a length of 170 millim. from snout to vent.

Inhabits Sardinia, Sicily, and South Italy *, Algeria and

* Dr. F. S. Monticelli informs me that it occurs at Portici, near Naples.

Tunis, north of the Sahara, and the intermediate islands; also Tripoli, Egypt, North-west Arabia, and Abyssinia.

D. Var. *vittatus.*

30–34 scales round the body (usually 32). Bronzy brown above, without ocelli; a light upper and a black lower lateral band. From snout to vent 115 millim.

Only known from Tangiers, where no other form occurs.

E. Var. *polylepis.*

34–40 scales round the body (usually 36–38). Dark brown above, usually with a small round yellowish spot on each scale; sides of neck with vertical black and white bars, which disappear in the adult. From snout to vent 150 millim.

Morocco. First noticed by Bœttger from Casablanca, Mogador, and the city of Morocco. Nine specimens from the city of Morocco and four from Casablanca are now in the Natural-History Museum.

LVII.—*On a new American Species of the remarkable animal* Phoronis. By E. A. Andrews, Ph.D., Johns Hopkins University, Baltimore, U. S. A.

Phoronis architecta, sp. n.

The following manifestly imperfect notice of an American form of the interesting genus *Phoronis* is published with the desire of calling the attention of embryologists to its existence in the hope that it may thus be the sooner known and perhaps included in a needed monograph of the group rather than from any desire of adding a new species to the present list of five or six, some of which are also insufficiently described.

The animal was found at Beaufort, N. C., in June 1885, inhabiting slender tubes standing upright in rather impure or muddy sand, both immediately in front of the building then occupied by the Chesapeake Laboratory and also upon "Shark Shoal."

The tubes are isolated and separate, each a clear, firm, chitin-like membrane passing down many inches into the sand and slightly projecting above its surface in regions laid bare at low water. The upper part of this tube is covered with a layer of sand, which seems as if selected, being composed of rounded grains of clear silex with a few of milky quartz, and no dark grains at all.

The animal fits tightly in the tube and cannot be easily removed; its length (in imperfect specimens) is about 50

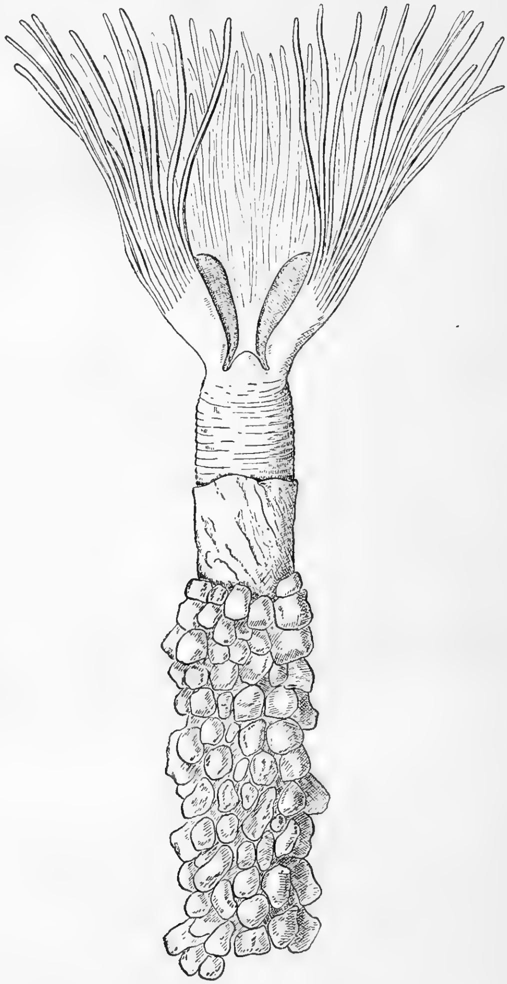


Fig. 1.—View of tube and branchial end of animal. The sand is removed from part of the tube, from which the animal projects. The branchiæ are artificially separated, to show the two large spoon-shaped organs and the papilla bearing the anal and nephridial openings. Camera drawing, Zeiss 4 *a*. *The branchiæ should be much shorter on the abanal or oral aspect!*

millim. and greatest diameter about 1 millim., while the branchiæ have a length of perhaps $1\frac{1}{2}$ millim.

The tentacles are about sixty and arranged in a simple crescent, as in *P. Kowalevskii*, Cald., with which this species has close affinities, rather than with *P. australis*, Hasw., or *P. Buskii*, M'Int.

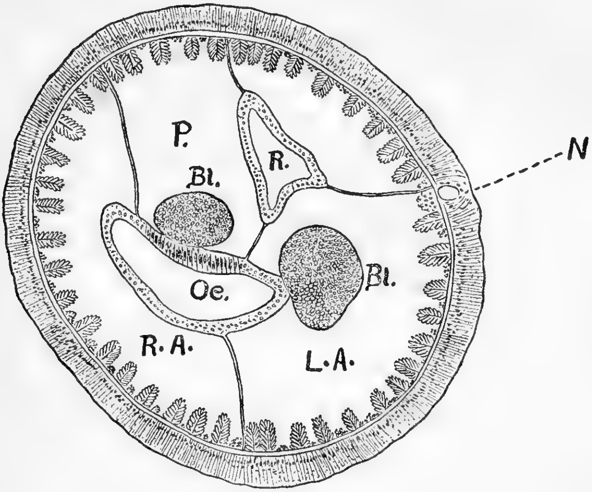


Fig. 2.—Transverse section of anterior region; the body-wall composed of a thick epidermis, a supporting layer, longitudinal muscles in definite pinnate ridges. In it is the left nerve-rod, N. R= rectum or intestine; Oe=œsophagus with special ridge next the blood-vessel (Bl) in the posterior cavity (P); R. A. and L. A. =right and left chambers of the body-cavity. Camera, Zeiss 5 A.

The marked peculiarity of the lophophore is the presence,

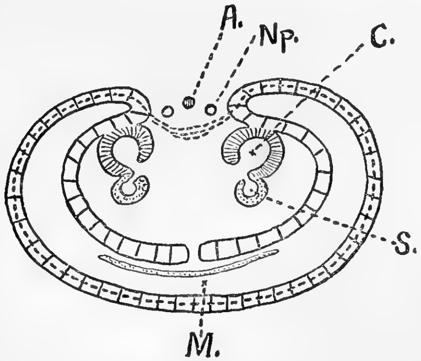


Fig. 3.—Diagram of section of base of lophophore on to which are projected sections of the carpel-like organ (C), the sense-lobe (S), and the anal and nephridial openings (A and Np). The mouth (M) is provided with a transverse epistomial membrane. The nerve-ring is indicated by a circumoral dotted line.

at each end of the crescentic base, of a large carpel-like or spoon-shaped organ, opening by a wide longitudinal slit into the extra-branchial or anal space, but facing towards the mouth (from which these organs are separated by the row of branchiæ between mouth and anus). The cavities of these organs are ciliated and lined by a peculiar glandular epithelium. At the base of each is situated a spherical "sense-lobe," apparently corresponding to the "glandular pit" of *P. Kowalevskii* as described by Benham, and having its ciliated cavity opening in common with the basal part of the slit in the above carpel organ. The function of this large carpel-shaped organ is unknown, but may be supposed to have some connexion with the tube-building habit, possibly as an organ for collecting or fixing sand-grains to the secreted chitin-like tube.

The body-wall presents in close contact with the inner aspect of its well-developed "supporting-tissue" layer transverse fibres (apparently muscular), internal to which is a very well-marked system of longitudinal muscles. Anteriorly these muscles form conspicuous ridges, a section of one of which shows the fibres to be arranged in a markedly pinnate group (each fibre is cylindrical, with abruptly pointed ends).

The branchiæ are ciliated on the lateral sides as well as on the oral side, and in the latter aspect have numerous unicellular glands, which continue down in the walls of what may be distinguished as the pharyngeal part of the digestive tube. The œsophagus and first stomach are characterized by the possession of a definite longitudinal ridge of ciliated gland-cells, which in the stomach forms a groove similar to, if not homologous with, the ciliated groove in the sipunculus. The position of this ridge is such as to lie close to the large blood-vessel (afferent vessel of Caldwell) and facing the posterior division of the body-cavity.

In the first stomach a peculiar process of intracellular digestion takes place, irregular ridges of epithelium rising up around one or more large diatoms, and enclosing them in vacuoles within a syncytium-like multinucleated protoplasmic mass.

The epithelium of the second stomach is histologically different from that of the first. The intestine contains balls or cylinders of broken diatom-shells.

In one apparently perfect specimen sections show only spermatozoa in various stages of formation, while fragments of other individuals contain eggs in process of formation. As far as can be told from the imperfect material at hand this species of *Phoronis* is not hermaphrodite, or at least the two sexual products may not develop simultaneously in one individual.

There is a very large "nerve-rod" on the left side, which is a clear solid structure surrounded by the epidermal cells and having a finely fibrillated or perhaps only coagulated structure. This rod extends through a considerable part of the length of the animal and ends in the peculiar ring of epidermal nerve-substance surrounding the mouth and especially well developed near the anus. At this point there are two symmetrically placed and closely approximated nerve-rods, of which, however, only the left one could be traced. The right rod appears not to extend far and to be atrophied as compared with the condition in *P. australis.*

Blood-vessels, septa, supporting framework, and nephridia seem essentially like those of *P. australis* as far as was determined.

In live specimens the flow of blood in the branchiæ, the contraction of the vessels and the cilia in the anterior region of the trunk were observed.

The *Actinotrocha* taken at Beaufort resemble the "species B" described by Wilson from the Chesapeake Bay.

The distinctive characters of *P. architecta* are thus:—The formation of isolated tubes covered by definite collections of sand-grains; the presence of special prostomial organs, possibly of use in formation of these tubes; the great development of the longitudinal muscles; the presence of a ciliated groove in the digestive tract; the apparent separation of the sexes.

As far as observed the characters of this species favour a nearer approach to the Sipunculid, and thence to the Annelid type, rather than to the Polyzoa on the other hand.

Baltimore,
April 19, 1890.

LVIII.—*Descriptions of three new Species of* Lycænidæ. By Colonel C. Swinhoe, F.L.S., F.Z.S., &c.

Lycænidæ.

1. *Arhopala viridissima*, n. sp.

♂. Upperside: fore wing glistening metallic green, veins, costal line, and outer marginal band black, the latter commencing very finely at the apex and gradually broadening on to the hinder margin; hind wing also metallic green, with a very broad black band, which occupies the greater portion of the wing, including broadly the costal, marginal, and abdominal portions; in reality the whole wing is black, with the exception of the cell and small portions of the interspaces around it, as in *A. eumolphus*, Cram., but the green runs into the black in sharper angles.

Underside paler than *A. eumolphus*, the bands coarser and composed of much larger and redder spots, but disposed much in the same pattern; a patch of blue-green irrorations at the anal angle of hind wings.

Expanse of wings $2\frac{2}{10}$ inches.

Mandalay, Upper Burmah, 1889. Six examples.

Allied to *A. eumolphus*, Cram.; is of a bluer green colour, and the difference in the size and shape of the marginal black band on fore wings at once distinguishes it.

2. *Rapala damona*, n. sp.

♂. Upperside dark coppery red, very similar in tint to the colour of *Deudorix epijarbas*, Boisd. ♂. Fore wing with a very broad blackish-brown marginal band, filling up the whole costal space down to the median vein, by which it is sharply defined, very broad at the apex, filling up very nearly the whole of the first median interspace, nearly as broad on the outer margin as on the costa, slightly curved in its centre, and expanding on to the hinder margin, up which it runs, narrowing towards the base in a diffused form; the base of the wing is also suffused darkly with brown, the wing being in point of fact black, with a red centre. Hind wing with the abdominal area brown, the entire cell being filled, and the first median branch limiting and sharply defining its lower area; anal lobe brown, marked with red and white; tail brown, with a white tip; veins on both wings brown, prominent; cilia brown, interlined with white round the lobe and up to the second median branch, and pure white on the abdominal border of hind wing.

Underside ochreous fawn-colour; a pale line across the end of each cell; a transverse, discal, slightly sinuous, pale line across both wings, inwardly lined with brownish, curved and bent towards the anal angle of the hind wing (as is usual in this genus), where it is pure white, with a fine black line between the white and the brown; anal lobe black, with a white spot above it; a black spot of the size of the lobe on the margin in the first median interspace, with a small reddish space above it, the space from the margin between the spots and the discal bent line brown, with bluish-grey speckles; cilia of both wings yellowish brown, cilia at the anal angle of hind wing white, interlined with deep black, the inner white line running in the cilia halfway up the wing.

Expanse of wings $1\frac{3}{10}$ inch.

South Andamans. Two examples.

Allied to *R. dieneces*, Hewitson, which it much resembles, but can easily be distinguished by the entire absence of the broad costal band of the hind wing above.

3. *Curetis nicobarica*, n. sp.

♂. Upperside bright dark coppery red, thickly suffused with blackish brown at the base. Fore wing with a blackish-brown marginal border, even on the costa to the end of the cell, filling the costal space, spreading slightly over the subcostal vein, broad at the apex, its inner margin running irregularly across from the top end of the cell towards the margin on the third median branch a little beyond its middle, from which the band runs down on to the hinder margin as broadly as on the costa, slightly curved in its centre. Hind wing with a broad costal and a narrower marginal uniform brown border, the latter about half as broad as the marginal border of the fore wing, its inner margin irregular.

Underside dull pure white, markings almost obsolete; costa of hind wing pale flesh-colour.

♀. Dark reddish brown. Upperside: fore wing with a slight suffusion of pinkish colour in its centre; hind wing with a curved, subapical, large whitish patch.

Underside dull pure white, markings nearly obsolete.

Expanse of wings, ♂ $1\frac{6}{10}$, ♀ $1\frac{7}{10}$ to $1\frac{8}{10}$ inch.

Nicobar Islands. Several pairs.

Allied to *C. thetys*, Drury, and to *C. arcuata*, Moore, but differs from both in its broader and differently shaped blackish-brown border in the male, and differs altogether in the coloration and appearance in the female, being brown instead of white.

Note.—The manuscript descriptions of these new species have been ready for publication for some time, but were kept back awaiting the publication of Mr. de Nicéville's third volume of the 'Butterflies of India;' but I find that none of them are included in that excellent work.

LIX.—*Revision of British Mollusca.* By the Rev. Canon A. M. Norman, M.A., D.C.L., F.L.S., &c.

More than twenty years have passed since my old friend Dr. Gwyn Jeffreys's work—'British Conchology'—was completed. In the decade which preceded that time we had in company dredged extensively round the British Islands, and especially in the sea east, west, and north of Shetland, down to 170 fathoms, which was the greatest depth at which, up to that time, the sea on our coast had been explored. The new species discovered in these expeditions mainly constituted the additions to our fauna for the first time to be found in the work referred to.

In 1868 private dredgings began to be greatly surpassed in importance by expeditions undertaken at the expense of our government. The President and Council of the Royal Society were successful in a request made to the Lords of the Admiralty. A scheme for deep-sea dredging was sanctioned, and the surveying-ship 'Lightning' commissioned for the work. In this steamer Drs. Carpenter and Wyville-Thomson explored the sea between Scotland and the Faroe Islands in depths down to 650 fathoms.

The results were most encouraging, and in the following year (1869) the 'Porcupine' was despatched for more extended operations to the south and west of Ireland and north of Scotland. The work of this year was a complete success, and discoveries were made, both physical and biological, of the highest value. Dredgings were carried down to 2435 fathoms. Drs. Carpenter, Jeffreys, and Wyville-Thomson were the scientific men in charge during these cruises.

The next important work which threw light upon the British marine fauna was that done by H.M.'s hired ship 'Knight Errant,' under the direction of Dr. John Murray, in the neighbourhood of the "Wyville-Thomson Ridge" in 1880.

In 1882 the government ordered the 'Triton,' a composite steamship of 410 tons, to resurvey and more thoroughly explore the remarkable geographical features connected with the sea-bottom on either side of the "Wyville-Thomson Ridge." Dr. John Murray had again the scientific direction in this expedition.

Last year (1889) a short dredging trip in deep water off the south of Ireland by H.M.S. 'Research' was superintended by Mr. G. C. Bourne, the Director of the Marine Biological

Association of the United Kingdom; and there was also some good trawling off the south-west of Ireland, conducted during a week's cruise in a hired steamer, the 'Flying Fox,' by the Rev. W. Spotswood Green, the deepest trawl being in 1000 fathoms.

In all these expeditions Mollusca have been found either hitherto undescribed or not before known to exist in the sea around the British Islands.

Dr. Gwyn Jeffreys was at the time of his death engaged in publishing a series of papers in the 'Proceedings of the Zoological Society' on the Mollusca obtained in the more important of these expeditions. He died before these papers were finished, and we therefore still remain in ignorance of what was found among many families of the Gastropoda. It is to be hoped, however, that Mr. E. A. Smith will before long complete the work with the help of MS. left by Jeffreys and such specimens as are in the British Museum.

Reference is, however, made in various papers published by Dr. Jeffreys to species of those families which were procured in the 'Porcupine' expedition. My friend, had his life been prolonged, would have drawn up a fresh list of the Mollusca which inhabit the British area. In attempting to do this now I shall have to mainly rely in the earlier part of this revision upon notes scattered through Dr. Jeffreys's various papers, while for the rest his account of "The Mollusca procured during the 'Lightning' and 'Porcupine' Expeditions" will supply the chief material as regards the deep-sea fauna.

It may be stated with respect to my purpose and revision generally—

1. That there were many cases of nomenclature adopted in 'British Conchology' with which I felt unable to agree at the time of its publication and am equally unable to acquiesce in now.

2. Many works have since been published, and the light which has been thrown from many sides on groups of Mollusca necessitates numerous alterations in nomenclature and arrangement.

3. Many recent malacological investigators of the Pteropoda (Boas, Pelseneer, Grobben, &c.) are agreed that these Mollusca should not be maintained as a distinct Class, but rather as an order or as families of the Gastropoda. That view is here followed.

4. Jeffreys not having studied the Nudibranchiate Mollusca requested Mr. Alder to draw up the account of that order. As Mr. Alder did not give the geographical distribution of the species, I have supplied this as far as I am able.

5. The distribution of the testaceous species has been very fully worked out by Jeffreys in 'British Conchology' and his subsequent papers. Distribution is for the most part only given here for the additions to the British list; nor have I thought it necessary to add further localities for well-known British species, except in the case of those which are most rare.

6. While the general arrangement of Fischer's 'Manuel de Conchyliologie' has in the main been adopted, it has in many points been departed from. Perhaps the chief of these is that Fischer has not been followed in dividing the Pelecypoda into the orders Tetrabranchiata and Dibranchiata, since such an arrangement in many cases widely divorces genera which seem in most points to be nearly related. I have here adopted the more recently expressed views of Dr. Dall.

7. Certain groups, such as the Pleurotomidæ, the Rissoidæ, and the Gymnoglossa, present unusual difficulties in arrangement by their shells, difficulties which can only be removed when we have become much more fully acquainted with the animals which form them. I have done the best I can with these groups, but am far from satisfied with the results. My endeavour has been to steer a middle course between those conchologists who excessively multiply genera and the arrangement of Jeffreys, who, in my opinion, made his genera too large—a course which he, subsequently to the publication of 'British Conchology,' most markedly departed from.

The British Area.

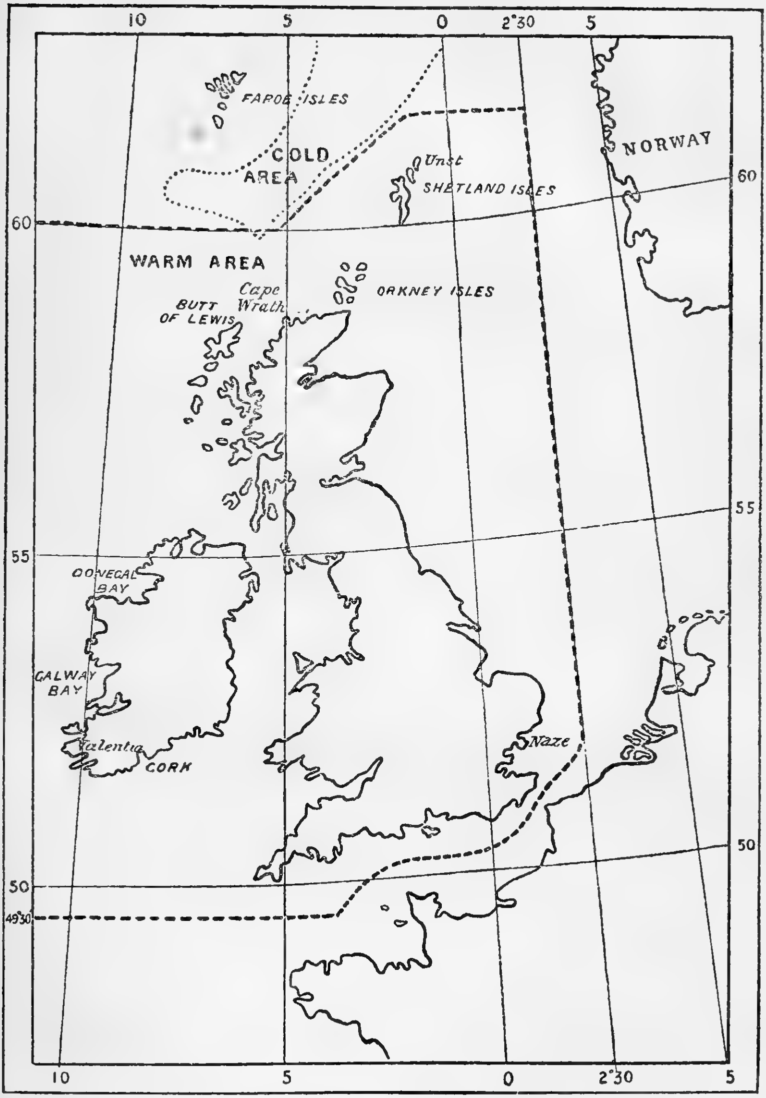
The area regarded as British is that which I have indicated in a paper on the subject printed in last month's number of this Journal ('Annals,' May 1890), where it is thus defined:—

South.—By lat. 49° 30′ N., which parallel passing eastwards terminates at long. 5° 0′ W., or midway between the Land's End and Brest. Thence mid-Channel is followed until lat. 51° 50′ N. is reached off the east coast.

East.—From lat. 51° 50′ N., long. 2° 30′ E. is taken as the eastern boundary northwards.

North.—Lat. 60° 0′ N., coming from the west as far as long. 5° 0′ W., thence due north-east to long. 1° 0′ W., thence due east to meet the eastern boundary at 2° 30′ E.

West.—Down to the base of the continent at 1500 fathoms.



The British Marine Area, showing its Southern, Eastern, and Northern Limits.

[The finely dotted line to the north indicates the boundaries of the "cold area" or "Faroe Channel."]

The following dredgings of the British Government expeditions were beyond the British area:—

1. '*Lightning*,' 1868.—Stats. 2 to 11, 15, 16, which were all too far north. The only stations therefore of this expedition which were within our area were 1, 12, 13, 14, 17.

2. '*Porcupine*,' 1869.—St. 11, in too deep water, 1630 fathoms; Stats. 33 to 42 too far south; Stats. 51, 52, 53, 54 to 64, 76, 77, 83, too far north. Three other dredgings should in my opinion, and in accordance with the views expressed in last month's 'Annals,' be excluded. Stat. 54, lat. 59° 46′ N., long. 6° 27′ W., 490 fath., temp. 31°·4 Fahr., and Stat. 86, lat. 59° 48′ N., long. 6° 31′ W., 445 fath., temp. 30°·1 Fahr., are slightly to the south of the northern boundary, but at that particular spot the Faroe Deep crosses lat. 60°, and the Faroe Ridge is to the south of it; consequently it is thus part of the "cold area" with the water below freezing-point *, and this little southern projection of the cold area should be rejected. Again, Stat. 65, lat. 61° 10′ N., long. 2° 21′ W., 345 fath., temp. 30° Fahr., is exactly on the boundary line which runs north-east, and the temperature being below freezing-point, this dredging I also exclude.

'*Porcupine*,' 1870.—No dredgings of this year were within our area.

3. '*Knight Errant*,' 1880.—Stats. 1, 2, 8 were too far north.

4. '*Triton*,' 1882.—Stats. 3 to 9 and 12 were too far north. The only dredgings in this expedition south of lat. 60° N. were 1, 2, 10, 11, and 13.

Great caution must be used in reading Jeffreys's notes of species in his scattered records. He often uses such loose expressions as "north of the Butt of Lewis" or "to the north of Scotland," when the shell was really found north of lat. 60° N. and in the "cold area" of the Faroe Channel.

The following is a list of papers by Dr. Jeffreys in which allusion is more or less made to Mollusca procured in the 'Porcupine' and other expeditions:—

1870. Carpenter, Jeffreys, and Wyville-Thomson. "Preliminary Report of the Scientific Exploration of the Deep Sea in H.M.S. 'Porcupine.'" Proc. Roy. Soc. vol. xviii. p. 397.

1870. Carpenter and Jeffreys. "Report Deep-Sea Researches, July–Sept. 1870, by H.M.S. 'Porcupine.'" Proc. Roy. Soc. 1870, vol. xix. p. 146.

* See my paper on "The British Marine Area" in 'Annals' for May 1890.

1870. Jeffreys. "Norwegian Mollusca." Ann. & Mag. Nat. Hist. ser. 4, vol. v. p. 438.

1870. ——. "Mediterranean Mollusca." *Ibid.* vol. vi. pp. 65, 457.

1872. ——. "Mollusca of Europe compared with those of Eastern North America." *Ibid.* vol. x. p. 237.

1873. ——. Mollusca in Wyville-Thomson's 'Depths of the Sea.'

1874. ——. "Some Remarks on the Mollusca of the Mediterranean." Report Brit. Assoc. for 1873, p. 111.

1876. ——. "Preliminary Report Biological Results of Cruise of H.M.S. 'Valorous' to Davis Strait." Proc. Roy. Soc. p. 177.

1877. ——. "Post-Tertiary Fossils and some recent Mollusca of Arctic Expedition." Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 229.

1877. ——. Address Biological Section British Association. Report Brit. Assoc. 1877.

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MOLLUSCA.

Class I. **CEPHALOPODA.**

The Cephalopoda are divided into two orders, those which have eight arms surrounding the mouth, and are therefore termed Octopoda, and those which, in addition to these eight arms, have two more of different structure, in which clubs furnished with suckers surmount long stalks; these are the Decapoda (or Decacera).

D'Orbigny arranged the Decapoda in two groups—

Oigopsides, in which the eyes have the crystalline lens unprotected by any special membrane, so that they are in immediate contact with the water.

Myopsides, in which the crystalline lens is protected from immediate contact with the water, being covered by a transparent membrane continuous with the orbital cartilages. An eyelid below the eye.

Gray and Fisher arranged this order by means of the differences of the shell—

Chondrophora.—Shell corneous, thin, gladius-shaped or lanceolate, a "pen."

Sepiophora.—Shell calcareous, spongy, laminar, a "cuttle-bone."

Phragmophora.—Shell calcareous, consisting of a number of air-chambers connected by a siphonal tube.

D'Orbigny's arrangement from the first was never received with much favour. But when, in the early investigations on hectocotylization, or the sexual modification of one of the arms in the male Cephalopod, this hectocotylization had been observed by Steenstrup in the various families of Myopsides, but not at all in the Oigopsides, he was led in his admirable paper on the subject * to regard that absence as proof of the wisdom of d'Orbigny's classification, and wrote "This summary" (of hectocotylization in the various genera) "furnishes a very striking evidence that there must be something natural in d'Orbigny's division of the Decapod Cephalopoda into the two principal groups 'Myopsides' and 'Oigopsides,' although no great inclination to adopt them has hitherto been shown. The difference in the conditions of reproduction shows especially that the genus *Ommatostrephes*, d'Orb., is still more entitled to be removed far from the genus *Loligo*, with which even modern malacologists, such as Verany and Troschel, persist in placing it." But all this is changed. The male of *Ommatostrephes* and its allies are described, and the males of other species of the Oigopsides are known. As far as thus known they closely conform in the hectocotylization of one of the ventral arms to this character in the genus *Loligo*. Moreover, it would now seem that the Oigopsid eye is not confined to the group Oigopsides, for Verrill has described a genus *Stoloteuthis* † which, though it is said in general characters to be closely allied to *Sepiola*, has this peculiar feature. He writes:—

* See translation, Ann. & Mag. Nat. Hist. ser. 2, vol. xx. (1857), p. 81.
† Verrill, Trans. Connect. Acad. Sci. v. (1881), p. 417.

"This species is the type of a very distinct genus, especially remarkable for being the only known genus among Myopsidæ that has round pupils and the eyelids free all around. In fact it shows quite conclusively that this division of the Decacera into two groups, based on the presence or absence of free eyelids, is purely artificial and of little or no systematic value." The conclusion I arrive at is that the division of the Decapoda into two primary groups by the character of the eye should be regarded as of secondary importance. Thus viewed the Oigopsida are a specialized and very natural group which should be kept together near to *Loligo*, while other considerations come in which appear to point to the desirability of breaking up the group Myopsides, though Steenstrup still maintains the Myopsides and Oigopsides as primary divisions.

The arrangement by their shells was first put forward by J. E. Gray *. He divided the Decapoda—or Sephenia as he called them—into three suborders, I. Chondrophora, II. Sepiophora, III. Belemnophora. Dr. Paul Fischer † has, in his recently published work, followed this arrangement, only substituting the preferable term Phragmophora for that of Belemnophora. This appears as a whole a very natural arrangement, and in it we seem to find the best guide to the archaic history of the class. The Phragmophora have the shell divided into air-chambers, as, for example, in the recent genus *Spirula*, in which "the multilocular shell corresponds with the phragmocone of the Belemnite" (*Owen*); and this recent genus is at once distinguished from the Sepiophora not only by the character of the shell, but by the absence or very rudimentary condition of the fins. Next come the Sepiophora, in which the septa are exchanged for a series of continuoŭs calcareous deposits, forming an internal shell of considerable size, but of such a spongeous character as still to be capable of retaining air; while the animal, which bears the sepia shell, differs from the Phragmophora and Chondrophora in its wide depressed form and in its fins, which usually fringe the whole length of the body. It agrees with both in having one of the lower or ventral arms in the male sexually affected; but here the hectocotylization is usually at the base, in the others at the extremity of, or rarely throughout, the arm. Next we come to the Chondrophora, where we find that "the primitive shell-gland and shell-sac have become fused"

* Brit. Mus. Cat., Cat. Mollusca in Coll. of B. M. pt. 1, Cephalopoda antepedia (1849).

† 'Manuel de Conchyliologie et de Paléontologie conchyliologique' (1887).

(*Hyatt*), and the shell itself is reduced in importance, narrow, lanceolate or spathulate, and its structure corneous, or sometimes altogether absent; and from these we pass to the Octopoda, where, as one of many wide differences of structure, the shell is rudimentary or wholly absent*.

It must not be supposed that I have been intimating in the preceding paragraph that the several groups of Decapoda have been derived from each other. That, I take it, certainly is not the case. They appear all to be derivatives in different directions from the ancient *Belemnites*.

No linear arrangement can ever adequately and fully demonstrate the varied alliances of groups. Such groups have diverged in many directions from earlier types, and while differing more and more widely in the especial characters in which their divergence is evidenced, will nevertheless be, so to speak, *laterally* bound together by the retention of many points in common during a shorter or longer period in their onward course of successive modifications. Again, the law of recurrence must be supposed to be not unlikely to come in. Organs which have been modified or to a greater or less extent suppressed under certain conditions of life and environment, when those conditions are partially or wholly reversed may be expected to revert more or less to their original condition rather than that they should undergo change in a new direction, although such new direction might equally subserve the same purpose. Again, the very same modifications which have taken place in a line of divergence which we will call A, may supervene at a much later period in another line of divergence B; for B had at an earlier time been undergoing modification in other parts of its structure than those at that same period followed by A, but when ultimately somewhat similar modifications having taken place in the same organ, which had long before diverged from the original type in A, the distant descendants of B may in this respect appear to us actually more nearly related to A than were its progenitors.

The Oigopsida preserve in their hooked acetabula (or suckers), in the indications of a phragmocone at the extremity of the internal shell (*Ommatostrephes*), and general form of body more of the characters of the ancient *Belemnites* than any other existing group. In *Belemnoteuthis antiqua*, Pearce, of the Oxford Clay, we seem to recognize a form which may represent a connecting-link; the arms are furnished with

* The beautiful egg-case of the genus *Argonauta* is not a true shell. It does not take its origin in a shell-gland, but is a secondary product of the dorsal arms, which are greatly expanded and turned back over the mantle.

hooked acetabula, the shell has its phragmocone largely developed, while the mucro, which is so conspicuous in typical *Belemnites*, is here almost evanescent. In the Solenhofen beds of Bavaria, which are supposed to be of nearly similar horizon to the Kimmeridge Clay, the genus *Acanthoteuthis* appears to be a decided Chondrophore, with hooked acetabula, and in *Conoteuthis Dupinianus*, d'Orb., from the Gault, we find a shell which shows approach to that of *Ommastrephes*, though the arms are unfortunately unknown.

Belemnites first appears, I believe, in the Jurassic formations. In the Lower Lias it is abundant, and with it is the genus *Geoteuthis*, which is perhaps a Chondrophore. In the Upper Lias occurs *Teuthopsis*, which is certainly a Chondrophore, but the specimens in the British Museum show no appendages to prove whether it is more likely to have been an Oigopsid or Myopsid; but forms ascribed to the same genus in the Oxford Clay have rather short and broad arms, which show no sign of hooked acetabula, and must belong to an animal allied either to the Ommastrephidæ or the Loliginidæ.

The Sepiophora first appear in the Kimmeridge Clay in *Coccoteuthis latipennis*, Owen, but the bone only is known; and there is in the British Museum an unnamed species from the Solenhofen deposits of Bavaria, the bone of which shows a very near approach to the form of the cuttle-bone in existing species of *Sepia*.

The origin of the Spirulidæ is most obscure. They are possibly derivatives from one of the more simple forms of Ammonite or from such a genus as *Spirulirostra*.

Classification by the shell is very valuable for that purpose with respect to fossil forms, since it is always preserved if any part of the animal is fossilized; while, on the other hand, the eyes are useless in the investigation of fossil forms, as their structure is rarely (if it is ever) recognizable. But while fully weighing this fact, and holding such classification to be a much truer division according to our present knowledge than that of d'Orbigny, it appears to me that our insight into the hectocotylization in this class has now attained sufficient importance to justify us in employing it as an important factor in classification. Steenstrup, in the paper to which I have already referred, insisted on its value. He wrote:—"The justification of the mode here adopted of employing the hectocotylized arm as a rule for the natural collocation of the forms lies in its importance for the entire reproduction. It would be inconceivable that the various occurrence of this metamorphosis, sometimes in one sometimes in the other pair of arms, sometimes on the right and sometimes on the left side, sometimes at the apex and sometimes at the base of the arm, &c., should not give rise to the same number of differences in the mode of fecundation, and in the positions and manner in which the seminal mass is placed upon the female, inasmuch as it appears that the semen is hardly involuntarily or mechanically emitted or poured out upon the eggs, but that this is effected by conscious movements. What is furnished us in this respect by simple reflection is also confirmed by observation. The seminal mass is actually attached to very different parts and under very different conditions." Professor Steenstrup, at the time he wrote that passage, was unacquainted with any instances of hectocotylization among the Oigopsides, and therefore thought that the discovery of hectocotylization had given strength to d'Orbigny's divisions; but, as has been already pointed out, hectocotylization breaks down that classification.

The following arrangement is suggested as one based primarily upon the sexual distinctions. At the same time it will not dismember d'Orbigny's natural group of Oigopsides, which will, however, take a subordinate place, nor will it in any way interfere with the arrangement by means of the shell, but, indeed, proceed nearly *pari passu* with it. It breaks up the Myopsides.

Subclass **DIBRANCHIATA.**

Order I. OCTOPODA.

MESARSENIA *.

Hectocotylization takes place in the third arm of the male, while some of the suckers of the other arms are in that sex much larger than in the female in certain genera; in others the tips of the arms under modification.

Order II. DECAPODA.

A. Chondrophora.

Suborder I. OPISTHARSENIA †.

One of the first or dorsal arms generally hectocotylized. Middle arms having some of the suckers in the male much larger than in the female.

* μέσος, middle, ἄρσην, male.
† ὀπισθιος, at the back, ἄρσην, male.

The Opistharsenia show many approaches to the Octopoda. 1st, the lateral arms of the male have enlarged suckers; 2nd, the body is short and ovate; 3rd, the fins almost invariably hold quite a different position from that assumed by them in the following suborders, being situated in the middle of the sides as in some Octopods; 4th, the shell is usually thin, corneous, narrow, and not more than half the length of the body, but is wholly absent in certain genera *.

The tentacular arms are retractile into cavities. The spermatophores are deposited at the orifice of the oviduct of the female. The formula of the radula is 2—1 . 1 . 1—2. Eggs isolated, though deposited in many gelatinous masses, each mass containing a large number of eggs.

Fam. **Sepiolidæ.**

Suborder II. PROSTHARSENIA †.

Hectocotylization of one of the fourth, *i. e.* ventral arms.

Section 1. ANOPROSTHARSENIA ‡.

In this section the terminal portion of the arm is that affected by hectocotylization, more rarely the entire arm undergoes modification (genus *Loliolus*). Body much produced, more or less cylindrical; fins at more or less of the hinder portion of the sides of the body and reaching its termination, or, if the body stretches beyond them, it is only as a pointed extremity. Shell internal, horny, thin, gladius-formed, or lanceolate.

Tribe 1. *Oigopsida.*

Eyes with a wide opening, through which the crystalline lens may project and be in immediate contact with the water. Spermatophores (in *Ommastrephidæ*) deposited in the branchial cavity of the female near the root of the gills. Formula of the radula usually 1—2—1 . 1 . 1—2—1. The middle and first laterals tricuspid, the outermost a very small quadrangular plate (but in the genus *Gonatus* there are only five teeth).

* *Stauloteuthis* and *Inioteuthis*, Verrill.

† πρόσθιος, in front, ἄρσην, male, in reference to the male having the fourth or front arm hectocotylized.

‡ ἄνω, from above, having the distal portion of the arm sexually affected.

Fam. **Cranchiidæ.**

Fam. **Chiroteuthidæ.**

Fam. **Ommastrephidæ.**

Tribe 2. *Myopsida* (restricted).

Eyes with a fibrose capsule attached to and continuous with the orbital cartilage, and transparent over the crystalline lens, which it covers. Spermatophores deposited under the buccal membrane of the female, which is especially modified for the purpose. Eggs in very numerous mucilaginous elongated masses, each containing very numerous eggs, and the whole attached together at one extremity. Formula of the radula and character of teeth exactly as in the Oigopsida of the genus *Ommatostrephes.*

Fam. **Loliginidæ.**

B. Sepiophora.

Section 2. KATOPROSTHARSENIA *.

Hectocotylization on the basal portion of the fourth or ventral arm of the male †.

Body wide, depressed; fins extending like a frill nearly the whole length of the body; shell calcareous, laminated, spongy, a cuttle-bone. Spermatophores attached under the buccal membrane of the female. Eggs ovoid, mamillated distally, and produced at the base into a stalk, by which they are attached to weeds. Formula of the radula 1—2 . 1 . 2—1, the central and two inner laterals are alike, triangular and simple, the outermost laterals are falciform.

Fam. **Sepiidæ.**

Mantle supported by a cartilaginous, semilunar or conical button, and a corresponding pit.

C. Phragmophora.

Shell (in *Spirula*) in the form of a number of air-chambers connected with each other by means of a siphon. Hectocotylization in both of the fourth or ventral arms.

* *κάτω*, below, having the basal portion of the front arm hectocotylized.

† *Sepia andreanoides*, Hoyle ('Challenger' Report), is exceptional in having the arm sexually affected to its extremity.

Fam. **Spirulidæ.**

Three genera which Steenstrup regards as allied to *Spirula*, *Sepiadarium*, *Sepioloidea*, and *Idiosepius*, Steenstrup, have no shell. Fischer places these genera in two families near the Loliginidæ. The hectocotylization of *Idiosepius* very closely accords with that of the male *Spirula australis* described by Owen; both ventral arms are entirely or almost entirely devoid of suckers, and one is of much larger size than the other. Steenstrup places the two groups Sepiadarii and Ideosepii in his family Sepio-Loliginei, and thus defines them :—

Group *Sepiadarii.* Fins narrow, occupying only smaller portion of the length. No internal shell. Mantle united to neck on the back. One of the fourth or ventral arms hectocotylized. Genera *Sepiadarium* and *Sepioloidea.*

Group *Idiosepii.* Fins small, terminal. Mantle supported by cartilaginous prominence or ridge and corresponding pit or furrow. Both ventral arms hectocotylized. Genera *Idiosepius*, which has no internal shell, and *Spirula.*

Being unacquainted with the foregoing interesting genera, I abstain from any conjecture as to their alliances.

Class I. **CEPHALOPODA.**

Subclass **DIBRANCHIATA.**

A. Mesarsenia.

Order I. OCTOPODA.

Fam. 1. **Octopidæ.**

Genus 1. Octopus, Lamarck.

Sars thus describes the radula in this genus :—“ Lamellæ radulæ medianæ magnæ, acie in cuspidem recurvam longe protractam exserta; laterales utrinque 2 valde inæquales, interior minima et rudimentaris, exterior magna, basi quadrangulari, acie unicuspidata; uncini utrinque singuli, falciformes, incurvi; laminæ limbi magnæ, quadrangulares. Formula radulæ 1—1—(1 . 1) . 1 . (1 . 1)—1—1.

1. *Octopus vulgaris*, Lamarck.

The males of *Octopus vulgaris* have one or more of the suckers (including generally the 14th to the 16th) of their lateral arms of disproportionately large size; at the same time the third right arm is much shorter than the left, distinctly thinner in its outer half, and the fold of skin, which is very white on the surface turned inwards, gives the arm an appearance as if the side of the arm were divided into two parts by a longitudinal cleft.

Guernsey and Herm (*A. M. N.*), Plymouth (*Biolog. Lab.*), Weymouth (*Hoyle, in litt.*), Liverpool (*Collingwood*), Lamlash Bay, Firth of Clyde (*Wyville Thomson*), Firth of Forth (*Grant and Neill*). It is desirable that these more northern habitats should be confirmed. Though stated to be "not uncommon" in the Firth of Forth, all Mr. Hoyle's endeavours to procure it from that locality have failed, and possibly *Eledone cirrosa* may have been mistaken for it.

2. *Octopus arcticus*, Prosch.

? *Sepia grœnlandica*, Dewhurst, Nat. Hist. Cetacea, 1834, p. 263.
Octopus arcticus, Prosch, K. Dansk. Vidensk. Selsk. Skrif. ser. 5, i. (1849), p. 53, figs. 1–3.
Octopus arcticus, Steenstrup, Ann. & Mag. Nat. Hist. ser. 2, xx. (1857), p. 97, pl. iii. fig. 2.
Octopus Bairdii, Verrill, Amer. Journ. Sci. 1873, v. p. 5; Trans. Connect. Acad. Sci. v. (1881), p. 368, pl. xxxiii. figs. 1, 1 *a*, pl. xxxiv. figs. 5, 6, pl. xxxvi. fig. 10, pl. xxxvii. fig. 8, pl. xlix. figs. 4, 4 *a*, pl. li. figs. 1, 1 *a*.
Octopus Bairdii, G. O. Sars, Moll. Reg. Arct. Norv. p. 339, pl. xxxiii. figs. 1–10, and dentition, pl. xvii. fig. 8.
Octopus arcticus, Hoyle, Report 'Challenger' Cephalop. p. 91.

Body short and thick, broadly rounded posteriorly, separated from head by only slight constriction at the sides. Lateral fold of the skin more or less distinct; lower portion of the body below the fold smooth; upper surface of body more or less studded, sometimes even to the arms, with roughish warts or tubercles of various size; often the largest of these is a supraorbital cirrus, which occasionally (and especially in the males) attains a considerable length, and is acutely conical and itself studded with lesser tubercles. Arms rather short, a connecting-web unites them for about one third of their length; they taper to very fine points; suckers small, little raised, those in each row separated from each other by a wide space often equalling their own diameter. Colour above dusky violet, below somewhat paler. In the male the right arm of the third pair is remarkably modified; it has its extremity greatly enlarged into a broadly elliptical spoon-like organ, of which the inner concave side is transversely divided by a number (thirteen in my specimen) of ribs which slightly incline forwards; anterior to these there is at the base a V-shaped fold, the point of the fold being directed forwards.

The largest Irish specimen has a total dorsal length from the extremity of the body to the end of a dorsal arm of 161 millim.; of this the body and head occupy 47 millim., the membrane connecting the arms 40 millim., and the free portion of the arm 74 millim.; breadth of body 45 millim. The animal was preserved in strong spirit.

"Lamellæ radulæ medianæ basi semielliptica, margine antico leviter emarginato, postice convexo, acie acuminata, marginibus lævibus, non denticulatis. Segmenta radulæ 64." (*G. O. Sars.*)

Mr. G. C. Bourne trawled two fine females of this species last year in H.M.S. 'Research' off the south of Ireland. The smaller specimen is not so tuberculate as the larger, and neither of them shows the more elevated supraorbital process, though that portion of the animal is more covered with prominent tubercles than the rest of the body. In this respect it accords with an American male for which I am indebted to the United States National Museum. Mr. Hoyle has also examined the specimens, and agrees with me that they belong to this species. I have also to thank that friend for information on several points on which I have consulted him in reference to the Cephalopoda.

Distribution. Octopus arcticus occurs off the whole north-east American coast from Newfoundland and Nova Scotia to South Carolina in 45-524 fathoms. G. O. Sars has found it off West Norway, Lofoten, and East Finmark in 80–300 fathoms. In the 'Porcupine' expedition it was twice met with in the Faroe Channel in 345–632 fathoms, and in the same Channel it was procured by the 'Knight Errant' in 540 fathoms, and by the 'Triton' in 608 fathoms; and if it be *Sepia grœnlandica*, Dewhurst, it also lives in the Greenland Sea.

Fam. 2. **Eledonidæ.**

Genus 2. ELEDONE, Leach.

Radula having the central tooth very large and acute. With two teeth on each margin towards the base; two laterals on each side, the inner small and rudimentary, the outer unicuspidate and large (but much smaller than the great central tooth); a single falcate uncinus on each side curving inwards, and exterior to this a very large oblong laminary plate. Formula 1—1—(1 . 1 .) . 1 . (1 . 1 .)—1—1.

3. *Eledone cirrosa* (Lamk.).

Outer Haaf, Shetland (*A. M. N.*), St. Andrews (*M'Intosh* !), Firth of Forth (*McBain*, *Hoyle*, *&c.*), Lamlash Bay, Arran, N.B. (*Herdman*), Tenby (*C. Jefferys* !), off S.W. Ireland, H.M.S. 'Research,' 1889 (*G. C. Bourne* !), Aberdeen and North Wales (*Hoyle*, *in litt.*), off the Butt of Lewis in 40 fathoms, 'Triton' exped. (*Hoyle*).

Distribution. Mediterranean, West France, Denmark, Sweden, West Norway, and Faroe Islands.

The males have the arms very long and greatly attenuated and they are not usually coiled up as in the female. Their extremities bear elongated and thin cutaneous lobes transversely placed and closely crowded together; the ends of these project in mature specimens beyond the margin of the arm like so many filaments, while in the centre of each lobe is a pore which represents the rudimentary sucker. In younger males these cutaneous expansions of the suckers are much smaller, and do not extend beyond the sides of the arms. The third right arm is hectocotylized, much shorter than the left, and very deep throughout. Along its lower margin there runs a fleshy lobe, which is curved upwards along the inner side of the arm, so as to form a channel throughout its length, and extending beyond the extremity of the arm (*i. e.* the portion bearing suckers), is there folded back and united to the inner side of the extremity; the termination of the channel is thus at the furthest point.

It is the *Sepia octopodia*, Pennant, *Octopus ventricosus*, Grant, and *Eledone Pennantii*, MacGillivray *.

Order II. DECAPODA.

A. Chondrophora.

Suborder I. OPISTHARSENIA.

Fam. 1. **Sepiolidæ.**

Genus 1. Rossia, Owen.

Body short, subglobose or oblong; anterior margin wholly

* Herr H. J. Posselt has recently (in "Petersen, Del Videnskablige Udbytte af Kanonbaaden 'Hauchs' Togter i de Danske Have inden for Skagen 1883-86" (1889), p. 139) pointed out distinctions between the males of *E. Aldrovandi* (Rafinesque) and of the present species. The differences are very slight, and how are the females to be distinguished? No doubt Herr Posselt represents not only his own views but also those of Professor Steenstrup; and I have in deference to their opinions here kept *E. cirrosa* as distinct from *E. Aldrovandi*.

free and unconnected by membrane dorsally with the head; *fins* more or less ovate, situated nearly centrally on the sides; *arms* rather short, their suckers in two or four rows; *tentacles* with angular or rounded stalks, their apices slightly expanded, with very numerous small suckers; *gladius* small, narrow. *Radula* with seven teeth in each transverse row, teeth unicuspidate, with smooth edges, formula 2—1 . 1 . 1—2. *Male* with some of the suckers of second and third arms much larger than usual and more pedunculated; one or both of the first (dorsal) arms more or less hectocotylized.

4. *Rossia macrosoma* (delle Chiaje), Gerv. & van Ben.

Sepiola macrosoma, delle Chiaje, Mem. stor. anim. (1829), pl. lxxi. (*fide* Gerv. and van Ben.).
Sepiola macrosoma, Gerv. et van Ben. Bull. Acad. Sci. Bruxelles, 1839, p. 39, pl. vi.
Rossia macrosoma, d'Orb. Céph. Acét. 1839, p. 245, Sépioles, pl. iv. figs. 13–24.
Rossia Owenii, Ball, Proc. Roy. Irish Acad. ii. (1842), p. 193, ♂.
Rossia Jacobi, id. ibid. p. 193, ♀.
Rossia Owenii, Lovén, Œfvers. k. Vetensk.-Akad. Förhand. 1845, p. 121.
Rossia Owenii, Forbes and Hanley, Hist. Brit. Moll. 1853, iv. p. 223, pl. SSS. fig. 1, ♂.
Rossia macrosoma, iid. ibid. p. 222, pl. MMM. fig. 1.
Rossia macrosoma, Jeffreys, B. C. iv. 1869, p. 133, pl. vi. fig. 1.
Rossia Panceri, Targ.-Tozz. Cep. Mus. Firenze, 1869, p. 46, pl. vii. fig. 7, ♂.
Rossia Oweni, Hoyle, Report 'Challenger' Ceph. 1886, p. 114, pl. xv. figs. 1–9.

In the 'Challenger' Report Mr. Hoyle doubtfully regarded *R. macrosoma* and *R. Oweni* as specifically distinct, and gave five characters in which he then thought they differed. We have now examined together the larger series of specimens in our joint collections, and I have his authority for stating that he no longer regards the first four points as tenable, though he is disposed to consider the fifth, namely that the tentacular suckers (on the margin of the club) are larger in *R. Oweni* than in *R. macrosoma*, as sufficient to separate the species. Now I grant that this seems to hold good when British and Mediterranean examples are actually compared; but the difference of size is very slight and only relates to the suckers near the base of the tentacular club, and I cannot think that such a slight variation is of sufficient importance to retain even a varietal name, much less specific. Some amount of variation must be allowed. Almost any Mediterranean shell can be distinguished by the practised eye from examples of the same species from our own seas; and in many cases if mixed lots of a shell were placed before me collected in the restricted area of our own seas I could at once pick out with certainty specimens of many forms which I could rightly, by differences of form, sculpture, and colouring, assign to their special habitats.

For description and good figures of the species I would refer to the 'Challenger' Report.

The males are at once known from the females by the outer rows of suckers of the arms, especially of the second and third pair, being much more developed than those of the central rows, while in the females the size of the suckers in all the rows is subequal. The left dorsal arm of the male is also to some extent hectocotylized.

This was formerly regarded as a very rare species on our coast; but the use of the trawl has shown it to be far from uncommon in 40–90 fathoms in the Clyde district and off the west of Scotland. It was also taken in the 'Porcupine' expedition in the Minch and off the coast of Wexford, and by the 'Triton' off the Butt of Lewis in 40 fathoms (*Hoyle*). Other localities are Dublin Bay (*Ball*), Isle of Wight (*Forbes and Hanley*).

Distribution. Kattegat (*Steenstrup*), South Sweden (*Lovén*), South and West Norway (*G. O. Sars*), Mediterranean (*d'Orbigny*), Naples (*Staz. Zool.* !).

Subgenus FRANKLINIA *.

Suckers of the arms in two rows only throughout their length. Besides the species here described the following will fall into this subgenus:—*R. megaptera*, Verrill, and apparently *Heteroteuthis tenera*, Verrill.

5. *Rossia glaucopis*, Lovén.

Rossia glaucopis, Lovén, Kongl. Vet.-Akad. Förh. 1846, p. 135.
Rossia papillifera, Jeffreys, B. C. v. (1869), p. 134.
Rossia glaucopis, G. O. Sars, Moll. Reg. Arct. Norv. 1878, p. 337, pl. xxxii. and pl. xviii. fig. 6.
Rossia glaucopis, Hoyle, Report 'Challenger' Cephalopoda, 1886, p. 116; id. Proc. Roy. Phys. Soc. Edinb. 1886, p. 24.

Two specimens taken by Jeffreys in 60–100 fathoms off the north of Shetland, and a specimen is in my collection which I dredged on the Outer Haaf, Shetland, in 1867.

Professor Steenstrup and Mr. Hoyle have both examined a specimen labelled in Jeffreys's handwriting "*Rossia papillifera*, Shetland," which appears to have been the type of *R. papillifera*, and they have identified it with Lovén's species.

* Named after Capt. Sir John Franklin, the Arctic voyager.

Distribution. A specimen was taken by the 'Porcupine,' 1869, St. 65, lat. 61° 10′ N., long. 2° 21′ W., 345 fath., temp. 30°·0 Fahr.* Finmark (*Lovén*), whole coast of Norway and East and West Finmark, 60–200 fath. (*G. O. Sars*).

The following is Sars's description of this species :—

"Corpus breve et obesum, supine papillis minutis sparsis obsitum, pallio ovato capite vix duplo longiore, margine antico in medio angulum obtusum formante, pinnis semicircularibus longe sejunctis ; brachiis robustis, lateralibus inferioribus longioribus dimidium corporis longitudinem superantibus, acetabulis magnis, biseriatis, regularibus ; tentaculis corporis longitudinem vix assequentibus, apice breviter dilatato, acetabulis minutis, longe pedunculatis, multiserialibus obsito. Color fusco-rufescens, chromotophoris numerosis minutis. Long., brachiis exclusis, 35 mm. Segmenta radulæ : 40.

6. *Rossia sublevis*, Verrill.

Rossia sublevis, Verril, Amer. Journ. Sci. xvi. (1878), p. 209, xix. (1880), p. 291, pl. xv. fig. 3 ; Bull. Mus. Comp. Zool. viii. (1881), p. 104, pl. iii. figs. 2–4, pl. vii. fig. 4 ; Trans. Connect. Acad. Sci. v. (1881), p. 354, pl. xxx. fig. 2, pl. xxxi. fig. 3, pl. xlvi. fig. 4, pl. xlvii. figs. 2–4.
Rossia sublevis ?, Hoyle, Report 'Challenger' Cephalopoda (1886), p. 117.

Mr. E. A. Smith records *Rossia sublevis* (Ann. & Mag. Nat. Hist. ser. 6, iv. (1889), p. 420) as having been taken in 1889 by the 'Flying Fox' in 250 fath. off the south of Ireland.

Distribution. North-east American coast, in 42–372 fath. (*Verrill*), and by the 'Blake' exped., lat. 32° 33′ N., 233–260 fath. (*Agassiz*).

Is this distinct from *R. glaucopis*? I cannot think so. Verrill's description of *R. sublevis* accurately accords with the characters of the former species. With respect to distinctions he writes :—"This species very closely resembles the *Rossia glaucopis*, Lovén, of Northern Europe, as figured by G. O. Sars. The latter is, however, more papillose and has smaller eyes and head, if correctly figured." But with respect to the papillosity Verril says, "Upper surface of the body and head

* This station is exactly on the line of demarcation of the British area, but from the temperature ought not, I think, to be regarded as British. It is impossible to define a more exact boundary than that I have given at this particular spot (see introductory notes). The next station, 66, at depth 267 fath., has temp. 45°·7 Fahr. Had I gone one half degree further east (*i. e.* 4° 30′ W.) for N.E. line of boundary, it would have fallen within the 100-fathom Shetland area in places.

nearly smooth, but in the larger specimens, especially the males, usually with a few whitish papillæ, most numerous near the front edge of the mantle." Now Verrill's largest specimens, which have the mantle 29–31 millim. long, are just the size of that figured by Sars, while my smaller Shetland specimen of *R. glaucopis*, length of mantle 13 millim., is nearly quite smooth. Again, as regards the form of the head, Verrill's two figures (pl. xxxi. fig. 3, and pl. xlvii. fig. 2) exhibit marked differences in form both of head, body, and of position of fins, as great as between one of those figures and that given by Sars; while my specimen has the eyes quite as prominent as they are represented in the latter figure of Verrill just referred to.

I have not united the species only because it is perhaps desirable that specimens of the two should be examined side by side before that is done.

Genus 2. Sepiola (Rondeletius), Leach.

Head dorsally attached to the body by connecting membrane. *Body* short, suboval or oblong. *Fins* latero-dorsal, rounded. *Head* almost as large as the body. *Eyes* prominent, covered by an expansion of the skin. *Tentacular arms* long, retractile, dilated at their extremities. *Arms* subulate, suckers generally two-rowed, but at the extremity sometimes many-rowed. *Males* have one of the first arms (left) hectocotylized and the third pair stronger than in female, and curiously forced down from their bases into the cavity of the mouth. *Gladius* lancet-shaped or linear, small, about half the length of the body. *Radula* as in *Rossia*.

7. *Sepiola scandica*, Steenstrup.

Sepiola Rondeletii, Leach, Zool. Miscell. iii. (1817), p. 140 (nec Gesner); Forbes and Hanley, Hist. Brit. Moll. iv. (1853), p. 220 (partim), pl. MMM. fig. 1.

Sepiola scandica, Steenstrup, Notæ "Teuthologicæ, 6," Overs. Danske Vidensk. Selsk. Förh. 1887, p. 65; Giard, Ann. & Mag. Nat. Hist. ser. 6, iv. 1889, p. 182; Posselt, in Petersen, Vidensk. Udbytte af 'Hauchs' Togter, 1889, p. 141.

Fins about equal to and not longer than half the entire length of the mantle. Suckers of all the arms two-rowed to their extremities. Valve of the funnel small in female, absent in male. Ink-bag simple, that is pyriform. Gladius narrow, linear or setiform.

Off Little Cumbrae, Firth of Clyde, 50 fathoms (*A. M. N.*); mouth of Loch Fyne, 48 fathoms, and West of Scotland (*Hoyle*).

Mr. Hoyle and myself have examined together the British and Mediterranean specimens of this genus (including *S. Rondeletii* and *S. Petersi* of the Mediterranean) which are in our two collections, and I only give those localities from which we have determined specimens. It must for the present remain in doubt whether the true *S. Rondeletii*, which is characterized by an auriculate or trilobed ink-sac, by fins equalling more than half (about three fifths) of mantle, and by having all the suckers of the arms two-rowed, occurs on our coast. Giard records it from Roscoff.

Distribution. Roscoff (*Giard*), Denmark, Sweden, South and West Norway, and Faroe (*Steenstrup and Posselt*).

8. *Sepiola atlantica*, d'Orbigny.

Sepiola atlantica, d'Orbigny, Céph. Acét. p. 235, Sépioles, pl. iv. figs. 1–12; Forbes and Hanley, Brit. Moll. iv. p. 217, pl. MMM. fig. 2; Steenstrup, Notæ "Teuthologicæ, 6," Overs. Kongl. Danske Vidensk. Selsk. Förh. 1887, p. 65; Hoyle, Fauna of Liverpool Bay, 1886, p. 279; Giard, Ann. & Mag. Nat. Hist. ser. 6, iv. (1889), p. 182; Posselt, in Petersen, Vidensk. Udbytte af 'Hauchs' Togter, 1889, p. 141.

Fins equal to more than half (about three fifths) the length of the mantle. Suckers of the arms two-rowed, but the fourth (ventral) arms having the suckers near their tips suddenly becoming many-rowed, very minute, and crowded in both sexes. Funnel furnished with a valve, which in the male is very much smaller than in the female. Ink-bag trilobed or auriculate. Gladius lanceolate or cultriform. In the male the suckers of the arms are fewer and larger than in the other sex. One of the first arms is largely developed, swollen, and widened laterally, with a hollow about the middle of its length. The third arms of male in this and other species of the genus are strongly forced down upon the oral opening.

Bantry and Jersey (*A. M. N.*), Plymouth (*Zool. Lab.* !), North Wales (*Hoyle*).

Distribution. Roscoff and Pas de Calais (*Giard*), Kattegat, South Sweden, South and West Norway, and Faroe (*Steenstrup and Posselt*).

Jeffreys united this species with the last as being its male !

Suborder II. PROSTHARSENIA.

Section 1. ANOPROSTHARSENIA.

Tribe I. *Oigopsida.*

Fam. 2. **Cranchiidæ.**

Genus Taonius, Steenstrup.

9. *Taonius hyperboreus*, Steenstrup.

Leachia hyperborea, Steenstrup, Ann. & Mag. Nat. Hist. ser. 2, xx. (1857), p. 96, note.
Taonius hyperboreus, Steenstrup, Overs. K. D. Vid. Selsk. Forhand. 1861, p. 83.
? *Desmoteuthis tenera*, Verrill, Trans. Connect. Acad. Sci. v. (1881), p. 412, pl. lv. fig. 2, pl. lvi. fig. 3.
Leachia ellipsoptera, Carpenter, Jeffreys, and Thomson, 'Porcupine' Report, Proc. Roy. Soc. 1870, p. 423.
Taonius hyperboreus, Hoyle, Report 'Challenger' Ceph. 1886, p. 191, pl. xxxii. fig. 12, and pl. xxxiii. figs. 1-11.

'Porcupine,' 1869. Two specimens at the surface 140 miles north-west of the coast of Ireland, lat. 56° 10′ N., long. 13° 16′ W. (*vide* Hoyle, 'Challenger' Ceph. p. 209).

Distribution. An oceanic species, the known distribution of which is North Greenland (*Steenstrup*), North-east America (*Verrill*), off Halifax, Nova Scotia ('*Challenger*').

Fam. 3. **Onychoteuthidæ.**

Genus Onychoteuthis, Lichtenstein, 1818.

Body long, subcylindrical; *fins* terminal, large, triangular, united dorsally, rhomboidal in their united form. *Eyes* large and prominent. *Arms* having two rows of suckers, which are furnished with horny but not denticulated rings. *Tentacular arms* long and strong, their clubs furnished at the base with a group of suckers, but the greater part of their length armed with two rows of strong grasping hooks. *Radula* very like that of *Loligo*, formula 3—1—3; all the teeth unicuspidate and simple, central and innermost lateral smaller than the others.

Pen with a long pointed dorso-posterior process.

I am not aware that the male of this genus has been described; but in the allied genus *Enoploteuthis* according to Claus hectocotylization takes place in one of the fourth or ventral arms, and the spermatophores are deposited in the ventral branchial cavity of the females.

10. *Onychoteuthis Banksii* (Leach).

Loligo Banksii, Leach, Zool. Miscell. iii. (1817), p. 141.
Onychoteuthis Bergii, Lichtenstein, Naturgesch. Brasiliens, 1818, p. 1592.
Onychia angulata, Lesueur, Journ. Acad. Nat. Sci. Philad. ii. (1821), p. 99, pl. ix. fig. 3, and p. 296, pl. xvii.
Onychoteuthis Banksii, d'Orbigny, Céph. Acét. 1855, p. 386.

Dr. Rose ('Zoologist,' 1853, p. 3864) records the capture of this species at Banff, Scotland. It is a species which was most unlikely to be mistaken, and, moreover, the specimen appears to have been examined by Arthur Adams; so that there can be no doubt that this oceanic species has been brought to our shores as others have been to the opposite continent.

Its distribution is very general in the Atlantic, Indian, and Pacific Oceans. In Northern Europe it has been recorded from South Sweden and Finmark (*Lovén*), Cattegat and Baltic Sea (*Posselt*).

Fam. 4. **Ommastrephidæ.**

Genus 1. Ommastrephes, d'Orbigny.

Subgenus 1. Ommastrephes, d'Orbigny (s. str.)
=*Ommatostrephes*, Steenstrup=*Sthenoteuthis*, Verrill.

Tentacular arms having the lower portion of their clubs furnished with numerous small smooth-rimmed suckers, alternating with tubercular processes (="fixing cushions," *Hoyle*) for their mutual adhesion. Ordinary suckers of the clubs in four rows. Arms provided with very broad thin marginal membranes. Caudal fin very broad.

Steenstrup separated the genera or subgenera *Illex* and *Todarodes* from *Ommastrephes* of d'Orbigny for certain species included by d'Orbigny in his Mon. Céph. Acét., and retained that author's name, changed in spelling to *Ommatostrephes*, for the remaining species with *O. Bartramii*, d'Orb. (=*O. cylindricus*, d'Orb.), as the type. Now the group thus restricted is the very one for which Verrill had previously proposed the name *Sthenoteuthis*: but both *O. Bartramii* and *O. gigas* belong to this group, and, as these were the only species originally placed in the genus by its author, *Ommastrephes* must by the laws of nomenclature be retained for it. The generic name cannot be applied to species subsequently included by him in the genus to the exclusion of those first embraced. Moreover, *O. Bartramii* had been taken by writers earlier than Verrill as the type. I follow therefore the nomenclature of Steenstrup and of Hoyle, except that I have treated *Illex* and *Todarodes* as subgenera.

11. *Ommastrephes eblanæ* (Ball).

Loligo eblanæ, Ball, Proc. Roy. Irish Acad. vol. i. p. 463.
Ommastrephes eblanæ, Forbes and Hanley, Hist. Brit. Moll. iv. p. 235, pl. SSS. fig. 2; Steenstrup, Ommat. Blæckspr. p. 97.

Body proportionately short; suckers confined to the clubs of the tentacles, minute and four-ranked at their extremities; fins occupying three sevenths of length of body. The arms bear remarkably large pedunculate suckers, two-ranked and set well apart.

These characters from Forbes and Hanley's description do not accord with any other British species. The four-ranked suckers of the tentacular clubs separate it from *O. Coindetii*, and the absence of suckers on the stems of the tentacular arms distinguish it from *O. sagittatus*.

The localities given by Forbes and Hanley are Dublin Bay (*Warren and Ball*) and Belfast (*W. Thompson*).

Subgenus 2. Illex, Steenstrup.

Distinguished from *Ommastrephes* (s. str.) by the absence of all simple suckers and tubercles employed for mutual cohesion on the tentacular clubs, and by the suckers of the club being arranged at the extremity in eight rows. The siphonal reception-groove is smooth at its commencement.

12. *Ommastrephes Coindeti* (Vérany).

Loligo Coindeti, Verany, Mem. Accad. Sci. Torino, vol. i. (1837), p. 94, pl. iv.
Ommastrephes sagittatus, d'Orbigny, Céph. Acét. 1839, p. 345, *Ommast.* pl. i. figs. 1–10 (partim); Forbes and Hanley, Hist. Brit. Moll. iv. (1853), p. 231, pl. RRR. fig. 1; Jeffreys, B. C. v. (1869), p. 129.
Loligo Pillæ (?), Verany, Céph. Méd. (1851), p. 112, pl. xxxvi. figs. *d–g*.
Illex Coindetii, Steenstrup, Ommat. Blæsp. Overs. D. K. Vid. Selks. Forh. 1880, pp. 82, 90, &c.; Hoyle, Report 'Challenger' Ceph. (1886), p. 34.

Additional localities. Firth of Forth (*Edinburgh Mus.*, fide *Herdman*); Eastbourne (*Roper*).

Distribution. Mediterraneann (*d'Orbigny &c.*), Naples (*Zool. Stat.* !), West and South-west France (*Fischer*).

A fine male in my collection from Naples shows that this species has the right ventral arm hectocotylized. This arm has its lower and outer margin, especially on the distal portion of its length, thickened and widened out laterally, so that the extremity is much broader than the corresponding part of the left arm; at about 1 inch from the extremity the suckers entirely cease, and what were the peduncles of the outer row are transformed into semielliptical vertical plates, which have the faces turned backwards and their summits bent over in that direction; the corresponding peduncles of the inner row are at first in the form of depressed simple tubercles, but quite at the extremity they also become flattened and closely correspond with those of the outer row opposite to them *.

Subgenus 3. Todarodes, Steenstrup.

Tentacular arms having their stems furnished with suckers some way down. Tentacular clubs not furnished at their base with simple suckers and fixing-cushions for their mutual adhesion; suckers arranged in only four rows quite to the extremity. Lateral arms not having a membranous crest. Siphonal reception-groove with small longitudinal grooves at the anterior end.

13. *Ommastrephes sagittatus* (Lamarck).

Ommastrephes todarus, Forbes and Hanley, Hist. Brit. Moll. iv. (1853), p. 233, pl. RRR. fig. 2; Jeffreys, B. C. iv. (1869), p. 128.
Todarodes sagittatus, Steenstrup, Ommat. Blæksp. (1880), pp. 82, 90, &c.; Hoyle, Report 'Challenger' Cephalopoda, 1886, p. 34.
(Non *Ommastrephes sagittatus*, d'Orb.)

Shetland (*Pearcey*!), St. Andrews (*M'Intosh*!), Firth of Forth (*Forbes*), Durham coast (*A. M. N.*).

It has a range coextensive with Europe from the Mediterranean to Finmark, Faroe, and Iceland.

The following is G. O. Sars's description of the radula of this species:—"Lamellæ radulæ in series 7 dispositæ, medianæ et laterales tricuspidatæ, cuspide centrali majore et longe protracta; uncini interiores basi intus acute producta, exteriores simplices, falciformes; laminæ limbales distinctæ, minimæ, quadrangulares. Formula radulæ 1—2—1 . 1 . 1—2—1." (*Sars*, l. c. pl. xvii. fig. 1.)

* Verrill has described the hectocotylization of the nearly allied American species *Ommastrephes* (*Illex*) *illecebrosus* (Lesueur). In the ventral arm of that species the suckers, especially of the outer row for some distance from the extremity, have their pedicels larger and longer, with swollen bases; then the suckers themselves gradually become smaller, till they nearly or quite disappear, and then close to the tip they may again become normal. Steenstrup testifies to hectocotylization of the same arm in *Todarodes* and *Dosidicus*, and in *Ommastrephes* (restricted).

Genus 2. ARCHITEUTHUS, Steenstrup.

14. *Architeuthus monachus* (Steenstrup), Verrill.

Architeuthus monachus, Steenstrup, Skand. Naturf. Förhand. vii. Möde, 1856, p. 182 (name only).
Architeuthis dux, Harting, Verhandl. k. Akad. Weten. ix. p. 11, pl. i.
Dinoteuthis proboscideus, A. G. More, Zoologist, 1875, p. 4526.
Architeuthis dux, A. G. More, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. 1875, p. 123.
Architeuthis monachus, Verrill, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. 1875, p. 268; Trans. Connect. Acad. Sci. v. 1880, p. 238; Amer. Journ. Sci. and Arts, ix. 1875, p. 124, pls. ii., iii., iv. figs. 9–13.

A species of *Architeuthus* has occurred several times on our coasts, and the species is considered by Verrill, who has seen more specimens of this genus than any other naturalist, to be *Architeuthus monachus*, Steenstrup.

"The mutilated carcase of a huge Cephalopod, perhaps belonging to Steenstrup's species (*Architeuthis monachus*), was stranded in 1860 or 1861 between Hillswick and Scalloway, on the west of Shetland. From a communication received by Prof. Allman it appears that the tentacles were 16 feet long, the pedal arms about half that length, and the mantle-sac 7 feet; the mantle was terminated by fins; one of the suckers examined by Prof. Allman was three quarters of an inch in diameter." (*Jeffreys*, Brit. Conch. v. p. 124.)

In the 'Zoologist' for July 1875, p. 4526, Mr. A. G. More called attention to a gigantic Cephalopod which was cast ashore at Dingle, in Kerry, 200 years ago. It was described as 19 feet in total length; the long arms were mutilated, the remaining part being 11 feet long and as thick as a man's arm; the short arms varied from 6 to 8 feet in length and were as thick as a man's leg, and had two rows of large serrated suckers; the proboscis or buccal mass with beak was capable of projection and of the "size of a man's hand," the beak was like an eagle's, but broader. The whole animal is said to have been as large as a large horse. Mr. More named this specimen *Dinoteuthis proboscideus*; but Verrill writes:— "There is no reason to suppose, from the published accounts, that this specimen differed in any way from *Architeuthis dux*."

"On the 26th April, 1875, a very large calamary was met with on the north-west of Boffin Island, Connemara. The crew of a 'curragh' (a boat made like a 'coracle' with wooden ribs covered with tarred canvas) observed to seaward a large floating mass surrounded by gulls. They pulled out to it, believing it to be a wreck, but to their astonishment found it was an enormous cuttle-fish, lying perfectly still, as if basking on the surface of the water. Paddling up with caution, they lopped off one of its arms. The animal immediately set out to sea, rushing through the water at a tremendous pace. The men gave chase, and after a hard pull in their frail canvas craft came up with it 5 miles out in the open Atlantic and severed another of its arms and head. These portions are now in the Dublin Museum. The shorter arms measure each 8 feet in length and 15 inches round the base; the tentacular arms are said to have been 30 feet long. The body sank." (*Sergeant Thomas Conner*, of the Royal Irish Constabulary, in the 'Zoologist,' June 1875.)

This specimen was described as follows by Mr. A. G. More under the name of *Architeuthis dux*, Steenstrup, in the 'Annals':—

"Tentacles 30 feet long when fresh (14 and 17 feet can still be made up from the pickled pieces). A few distant, small, and nearly sessile suckers occur at long intervals along the inner surface of the peduncle. The club, measuring 2 feet 9 inches in its present shrunken state, is occupied in the centre of the palm by two rows of large stalked suckers nearly 1 inch in diameter, fourteen in each row; an alternating row of fourteen smaller suckers (half an inch in diameter) occupies the margin on each side of the palm; thus there are twenty-eight large one-inch suckers in the middle, and the same number of half-inch suckers along the outer edge. These outer suckers are each armed with a denticulated bony ring of some twenty-eight teeth pointing inwards; and no doubt the large inner suckers were similarly furnished, but their rings had fallen out or had been removed before the specimens were examined. Just beneath where the large suckers end there occurs a cluster of small suckers, two tenths of an inch in diameter; and these are arranged closely in six transverse rows for about 5 inches along the now narrowing wrist of the club; only a few of the uppermost of these are furnished with denticulate rings; the greater number, like the few small suckers of the peduncle, are sustained by rings with an entire or smooth edge. Above the large suckers of the palm the club tapers upwards, and is again clothed with a great number of small and apparently smooth-ringed suckers.

"The short arm is quite spoiled for examination: all the horny rings are gone; and the suckers themselves are scarcely represented. This arm measured 8 feet in length, and 15 inches round the base, when fresh.

"The beak has a strong wide tooth above the middle of the edge of the inner mandible, and a much narrower notch on the outer mandible, on each side. The head and eyes were unfortunately lost."

Steenstrup states that *Plectoteuthis*, Owen (1881), is the hectocotylized arm of a male *Architeuthus*.

Tribe II. *Myopsida* (restricted).

Fam. 5. **Loliginidæ.**

Genus Loligo, Lamarck.

Hectocotylization takes place in this genus on one of the lower or ventral arms, on the basal portion of which the suckers are normal, after which the size of the sucking-disks gradually diminishes, while that of their peduncles increases in length, till ultimately the disks entirely disappear and papillæ alone remain, which give the extremity of the arm a fringed-like appearance when viewed from the side. In certain exotic species only one side of the arm is thus affected; but in the European forms both rows of suckers are similarly aborted.

[*Loligo vulgaris*, Lamarck (but not *L. vulgaris* of British authors).

Anterior part of sides of body and ventral surface spotted; some of the spots often take a ring-like form, but the body is not painted with long dark markings. Tentacular arms having the central rows of suckers large, the lateral very much smaller, so that the diameter of the latter is only half that of the former and their height one third. Disks of central rows of tentacular arms two to three times as large as largest suckers of third arms, their horny rings having only half their circumference finely toothed, whilst the other half is toothless or only bears a group of four or five small blunt teeth (in the northern form, says Steenstrup, these are indeed the only teeth in the horny ring); suckers of lateral rows with high pointed teeth on the upper half, while the lower half is almost toothless.

Mediterranean, Adriatic, Denmark (*Steenstrup*).

This more southern form will probably be found on our coast; but all the specimens which both Mr. Hoyle and myself have examined belong to the next species.]

15. *Loligo Forbesii*, Steenstrup.

Loligo vulgaris, Forbes and Hanley, Brit. Moll. iv. (1853), p. 226, pl. LLL.

Loligo Forbesii, Steenstrup, K. D. Vid. Selks. Skr. ser. 4, iv. (1856), p. 189, pl. i. fig. 2; Ann. & Mag. Nat. Hist. ser. 2, xx. (1857), p. 84.

Loligo magna, Adams, Gen. Rec. Moll. (1858), pl. iv. fig. 3.
Loligo vulgaris, Jeffreys, B. C. v. (1869), p. 130, pl. v. fig. 2.
Loligo Forbesii, Lenz, Jahresb. Comm. Kiel, Jahrb. i. (1871), p. 135; Hoyle, Proc. Phys. Soc. Edinb. viii. (1885), p. 459.

Anterior part of sides of body and ventral surface painted with long dark markings. Tentacular arms having the suckers of the central rows scarcely exceeding in size those of the lateral rows either in diameter or height, so that the club looks as if it bore four series of subequal suckers. The disks of the central rows of the tentacular arms are scarcely one third larger than those of the central rows of the third arms; their horny rings bear numerous pointed teeth all round, usually larger and smaller alternately; suckers of lateral rows completely set with teeth of equal size. Length of ordinary specimens 2 feet.

St. Andrews (*M'Intosh!*), Plymouth (*A. M. N.*), Durham and Northumberland coasts (*J. Alder!*); a pen from the Northumberland coast in the Newcastle Museum measures 22 inches in length. Firth of Forth (*Hoyle*).

Jeffreys reunited Steenstrup's species with *L. vulgaris* on the ground that the differences might be sexual, quite overlooking the fact that Steenstrup expressly states, respecting Danish examples, "Of both species I have only been able to examine the males on our coast."

16. *Loligo marmoræ*, Verany.

Loligo marmoræ, Verany, Céph. Médit. 1851, p. 95, pl. xxxvii.; Forbes and Hanley, Hist. Brit. Moll. iv. (1853), p. 230, pl. QQQ. fig. 2.

Off Youghal (*Dr. Ball*, fide *F. & H.*). I have not seen any British specimens of this species.

Mediterranean examples are in my collection from Naples (*Staz. Zool.*) and Nice (*Gal.*).

A mere glance at once distinguishes the form from that of the next species, for while the latter exhibits variation in the proportion of parts of the body, still the body as a whole, as far as I have seen, never assumes the appearance of *L. marmoræ*, which is distinguished by the much broader fins, generally situated further back, and which, reaching quite to the extremity, give an altogether different look to the animal from that of *L. media*. The following are measurements of four specimens:—

	Total length of mantle on the back. millim.	Length from front margin of fin to the extremity of body. millim.	Greatest breadth of fin. millim.
Naples, ♀	69	35	25
" "	60	30	25
Nice, ♀	105	66	46
" "	93	55	41

The difference between this and *L. media* is certainly not sexual.

17. *Loligo media* (Linné).

Loligo subulata, Lamarck, Mém. Soc. Hist. Nat. Paris (1799), vol. i. p. 15.
Loligo spiralis, Férussac, Dict. Class. Hist. Nat. iii. (1853), p. 67, no. 6.
Loligo parva, d'Orbigny, Céph. Acét. 1848, p. 130, Calmars, pls. xvii. and xxiii. figs. 19–21.
Loligo media, Forbes and Hanley, Brit. Moll. iv. 1853, p. 228, pl. QQQ. fig. 1; Hoyle, Fauna of Liverpool Bay, 1886, p. 279.

I give the following measurements for comparison with those of the preceding species. The first specimen is a male remarkable for its extremely produced form.

	Total dorsal length of mantle. millim.	Length from front margin of fin to extremity of body. millim.	Greatest breadth of fin. millim.
1. Plymouth, ♂ ..	112	77	28
2. " ♀ ..	85	49	30
3. " " ..	83	49	30
4. " " ..	83	53	27
5. " " ..	74	44	28
6. " " ..	73	42	26
7. Tenby, ♀	82	52	30
8. " "	79	47	28
9. " "	81	52	26
10. Jersey, ♀	76	47	29
11. " "	63	36	21

These measurements of the two species will show that there is great variation in proportion of parts in each, but that at the same time first that in *L. marmoræ* the portion of the body behind the commencement of the fin is less in proportion to the total length, and secondly that the breadth of the fin is greater in proportion to the distance between its commencement and the termination of the body, so that the triangle thus formed is much less produced. Moreover in *L. marmoræ* the fin is continued to the extremity, whereas in *L. media* it runs out at some distance from it; in specimen 1 of that species (a male remarkably elongated) it disappears at 45 millim. from the much-produced extremity.

The left ventral arm of the male is hectocotylized as described under the genus; but in this species a further modification takes place in the fact that the normal suckers at the base of the arm are smaller in size than the corresponding suckers of the right ventral arm.

Specimens in my collection are from Jersey (*Sinel*), Tenby (*C. Jeffery*), Plymouth (*Biol. Lab.*). I have also found it in Lamlash Bay, Firth of Clyde. North Wales (*Hoyle*). It has been found in many other places on our southern coasts, but it becomes scarce northwards.

Distribution. In consequence of this species being so frequently confounded with the preceding I hesitate to quote records of its occurrence. It is not without much doubt that I have kept them distinct; but judging from the specimens I here record they appear to be so.

B. Sepiophora.

Section 2. KATOPROSTHARSENIA.

Fam. 6. **Sepiidæ.**

Genus Sepia, Linné.

18. *Sepia officinalis*, Linn.

The distribution of this species is West Africa, Mediterranean, Spain, France, British Islands (chiefly southern coasts), Sweden (Norway ?) *.

Hectocotylization takes place in *Sepia* on the lower portion of the fourth or ventral arm. In *S. vulgaris* it is the left arm which is thus affected. It is widened out near the base, only two or three suckers in each row are at the origin of the arm normally developed, whilst the seven or eight following suckers in each row become very small or almost evanescent; the arm, widened much at this part, has the muscles developed in a peculiar manner, "becoming elevated, lying like oblique beams across the arm, and partially crossing amongst themselves, by which means a number of pits are formed, which are especially deep towards the upper margin. Lastly, in these pits and on the portions which separate them the skin is everywhere folded into elevated, thin, membranous laminæ, which run together into a reticulated form and give the whole surface of this part of the arm a certain resemblance to the inside of a calf's stomach." (*Steenstrup.*)

* Fischer makes the Mediterranean form a distinct species from the northern, and names it *S. Filiouxii* (see Journ. Conch. xviii., xx., xxi., xxii.). If that be so, the more southern localities here quoted probably belong to that species.

The radula has seven teeth in each transverse row; all the teeth are simple and of nearly equal size, except the outer laterals, which are longer.

The eggs are ovoid, with a mamillary distal extremity, and narrowed at their base into a stalk, with which the seaweed to which they are attached is grasped.

Besides the hectocotylization of the arm in the male, the cuttle-bone is smaller and less hollowed than in the other sex.

19. *Sepia rupellaria*, d'Orb.

Sepia rupellaria, d'Orb. & Férussac, Céph. Acét. (1839), p. 275, pl. iii. figs. 10–13.

Sepia biserialis, Verany, Céph. Médit. (1851), p. 73, pl. xxvi. figs. F, K; Forbes and Hanley, Hist. Brit. Moll. iv. (1853), p. 241, pl. PPP. fig. 2; Jeffreys, B. C. v. (1869), p. 141.

Magilligan, north of Ireland (*Hyndman*), Northumberland coast (*Alder*, the specimen now in the Newcastle Museum), Polperro (*Loughrin*), Oxwich Bay, Swansea (*Jeffreys*).

Distribution. Naples (*Zool. Stat.*!), Nice (*Gal.*!), Noirmoutiers and La Rochelle (*d'Orbigny*).

20. *Sepia elegans*, d'Orbigny.

Sepia elegans, d'Orbigny, Seiches (1826), pl. viii. figs. 1–5; d'Orbigny & Férussac, Céph. Acét. 1839, p. 275, Seiches, pl. viii. figs. 1–5, pl. xxvii. figs. 3–6; Jeffreys, B. C. iv. 1869, p. 140.

Jersey (*A. M. N.*), Polperro, Cornwall (*J. Couch*, in Alder's Coll. in Newcastle Museum), Guernsey (*Lukis*), Oxwich Bay, near Swansea (*Jeffreys*).

Distribution. Messina, Adriatic, coast of Algiers, and Malaga (*d'Orbigny*), Naples (*Zool. Stat.*!), Nice (*Gal.*!).

[C. Phragmophora.

Shell in the form of a series of air-cells, connected with each other by means of a siphon.

Fam. 7. **Spirulidæ.**

Genus Spirula, Lamarck.

Spirula Peronii, Lamarck.

Spirula Peronii, Forbes and Hanley, Hist. Brit. Moll. iv. (1853), p. 242.

Dead shells occasionally washed to the western shores of Great Britain as well as of the rest of Europe, but never taken alive so far north.]

[To be continued.]

LX.—*On a new Sparrow-Hawk from Madeira.* By R. Bowdler Sharpe, F.L.S. &c.

My colleague Mr. W. R. Ogilvie Grant has just returned from a three weeks' trip to Madeira, and amongst many interesting species of birds obtained during his residence on the island was a female Sparrow-Hawk which turns out to be a most interesting insular form of *A. nisus*, quite sufficiently characterized to deserve a specific name. I therefore call it after my energetic friend and colleague

Accipiter Granti, sp. n.

♀ ad. similis *A. nisi* ♀, sed ubique saturatior, supra schistaceo-nigricans; subtus late et regulariter nigro fasciatus; tibiis, subalaribus et axillaribus late nigro fasciatis.

Long. tot. 15·5, culm. 0·75, alæ 8·7, caudæ 6·9, tarsi 2·3.

Although the comparative diagnosis given above would make it appear that the similarity of this new Sparrow-Hawk to the common species of Europe is very marked, the differences between them are really very pronounced, and when, as I hope it will do shortly, a figure of the Madeira species appears in the 'Ibis,' it will be seen that a very interesting Accipitrine bird has been added to our list of species of the Western Palæarctic Region. The Madeira bird is in fact very closely allied to *Accipiter madagascariensis*, but it possesses a well-marked chestnut tuft of plumes on the flanks, which shows that its real affinities are with *A. nisus*, as this character is always wanting in the Madagascar bird.

MISCELLANEOUS.

British Fossil Crinoids. By F. A. Bather, M.A., F.G.S.

II. *The Classification of the Inadunata Fistulata* (continued from p. 388).

Corrigenda.

There are a few unfortunate errors and obscurities in the earlier portion of this paper; though they do not affect the argument, it is best to correct them without delay. And at the same time I must thank Dr. P. H. Carpenter for having kindly called my attention to them.

P. 311, last line, *for* "excretion" *read* "the discharge of excrement." "Excretion" in scientific language means "the discharge of a *secretion*;" excrement is not a secretion.

P. 313, last line, *for* "Miller" *read* "Müller."

P. 315, line 3, *for* "B and C as Right, D and E as Left" *read* "B and C as Left, D and E as Right;" I must apologize to Dr. Carpenter, and indeed to my readers generally, for this very bothering slip.

P. 315, second line after Table, instead of "Chambered Organ" *read* "plane separating the Stem from the Calyx." This plane is chosen because of its nearness to the Chambered Organ, the capsule of which is the Governing Organ of the animal's movements; the Chambered Organ, however, is, as a rule, actually above the Infrabasals.

P. 318, line 10, *for* "basals and infrabasals" *read* "infrabasals (as well as basals)." The quotation from Wachsmuth and Springer, in inverted commas, refers only to infrabasals; the application of it to basals was inaccurate and at the same time weakened my argument. Nevertheless a mere correction would not be quite fair, for it is a fact, as Mr. Wachsmuth has elsewhere pointed out, that the basals also are proportionately large in the young.

Pp. 320 *et seqq.* The sign R+ is of course the same as R× of p. 333 and of Plate XIV.; but R′ is an intentional difference. An unfortunate though blameless mistake in sending out the proofs prevented me from correcting them quite as closely as I could have wished.

P. 323, 2nd and 3rd lines from bottom. Some may think that they see a misrepresentation here. I have represented Messrs. Wachsmuth and Springer as saying that the azygos plate is as much radial as interradial. A correct quotation would have been "the azygous plate in *Baerocrinus* is &c." But since they consider this plate in *Baerocrinus* to be homologous with the radianal (which I do not), and since they in the very next sentence imply that it is in an ancestral stage, it is clear that a simple and exact quotation would not have given their complete meaning but would have tended to confuse the issues. Accuracy, even pedantic accuracy, is not to be despised; but to one summarizing an argument, the spirit usually seems more worthy of retention than does the letter.

On a few Californian Medusæ. By J. Walter Fewkes.

The author gives the results of his investigations on the Medusæ of the coast of southern California—chiefly of the Santa Barbara Channel, into which the vast waters of the Pacific carry many strange organisms. He describes a new *Pelagia* (*P. panopyra*), a new *Aurelia* (*A. labiata*), which, however, closely resembles *A. flavidula* of the Atlantic shores, and *Polyorchis penicillata*, A. Agassiz, a form having intermediate characters (resembling both Anthomedusæ and Leptomedusæ), for no otocysts occur on the margin of the umbrella as in the former, while the reproductive organs are on the radial canals, as in the latter. Another form, *Dipurena*, has an umbrella like *Sarsia*, but with nine short, clavate, marginal tentacles. The reproductive organs occur in the manubrium, as in the genus mentioned. *Microcampa*, n. g., again, has six radial canals instead of four, and a single, club-shaped, inflexible tentacle. It is probably an immature form. Another Medusoid is *Hybocodon*—probably near *Steenstrupia*—in which the buds arise near the long solitary tentacle bristling with rings of nematocysts. Each bud has a single tentacle. The interest in connexion with this form is the more vivid since a very similar form is found in St. Andrews Bay, though in the latter case the much larger buds present two tentacles, while in the adult two shorter tentacles occur near the long one, each springing from a similarly enlarged base. Mr. Fewkes figures these two tentacles, but is of opinion they arise from the buds. As at St. Andrews the buds showed two tentacles, further investigation on this point would be satisfactory. The author concludes his very interesting paper, which is illustrated by six beautiful plates, with a notice of *Sarsia rosaria*, probably from a *Syncoryne* abounding on the piers of a wharf, and with notes also on a Campanularian, on *Willia*, *Athorybia*, and *Velella*. W. C. M.

Chemical Researches on the Fossil Tests of Foraminifera, Mollusca, and Crustacea. By M. Stanislas Meunier.

M. de Folin having obtained a flocculent residue by the treatment of Nummulitic rocks from Biarritz with acids, came to the conclusion that this was of organic nature, and regarded it as *sarcodic material*. He called the author's attention to the subject, who carefully repeated the experiments upon Nummulitic rocks from the neighbourhood of Paris. Examples of *Nummulites lævigatus* were partially dissolved in dilute hydrochloric acid until they were quite cleared and milk-white; they were then dissolved in fresh acid, and the residue, amounting to 2·233 per cent. of the Nummulites, was examined.

This residue had the appearance of very fine clay, but on heating to redness some portions on platinum foil they became brown, then carbonized, and after combustion left a reddish residue. On heating the substance in a tube with some soda-lime a strong evolution of ammonia took place. It is therefore a nitrogenous substance.

This supposed animal substance, however, forms only 16·66 per cent. of the flocculent mass, and the mineral material associated with it renders analysis difficult. The results of analysis, given with some reserve, are as follows:—

Carbon	64
Hydrogen	5
Nitrogen	12
Oxygen (difference)	19
	100

The author has repeated the experiments with similar results in the case of other French Foraminiferal rocks.

By the advice of M. Milne-Edwards he extended his researches to the fossilized tests of various Mollusca and Crustacea, among which he cites *Psammocarcinus Hericartii* and *Cytheræa splendida*, and in all cases obtained the organic compound with the same composition and properties. As in the case of the Nummulites the substance is light grey, with a peculiar silky lustre, and it is mixed with a very considerable amount of mineral elements, consisting especially of small acicular crystals of carbonate of lime.

The author believes that in the organic compounds obtained we have a residue of the fossil animals which may be compared with the carbonaceous combustibles of vegetable origin, and that it is to their presence that we must ascribe the discovery of nitrogen so frequently repeated by Delesse in his analyses of sedimentary rocks. —*Comptes Rendus*, March 17, 1890, p. 597.

INDEX TO VOL. V.

END OF THE FIFTH VOLUME.

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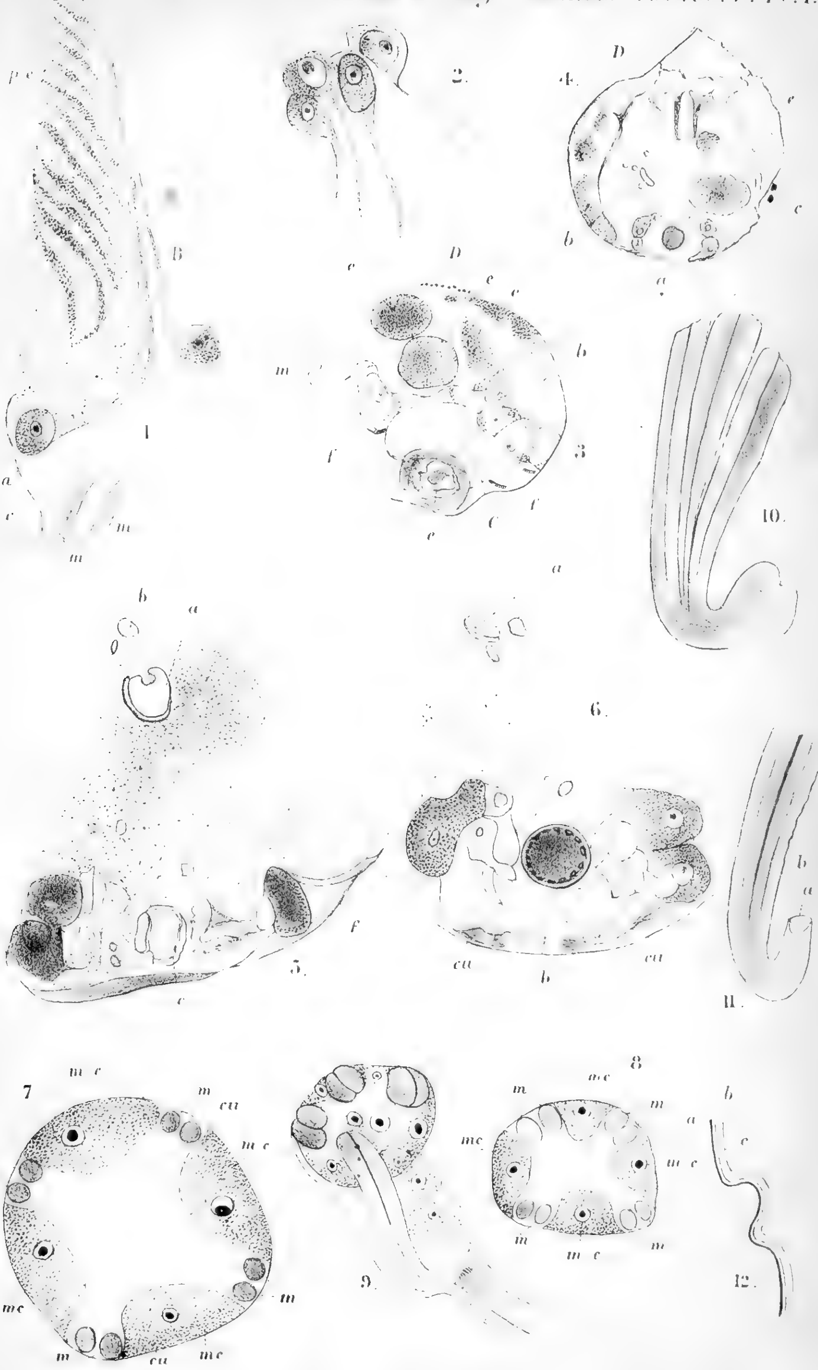

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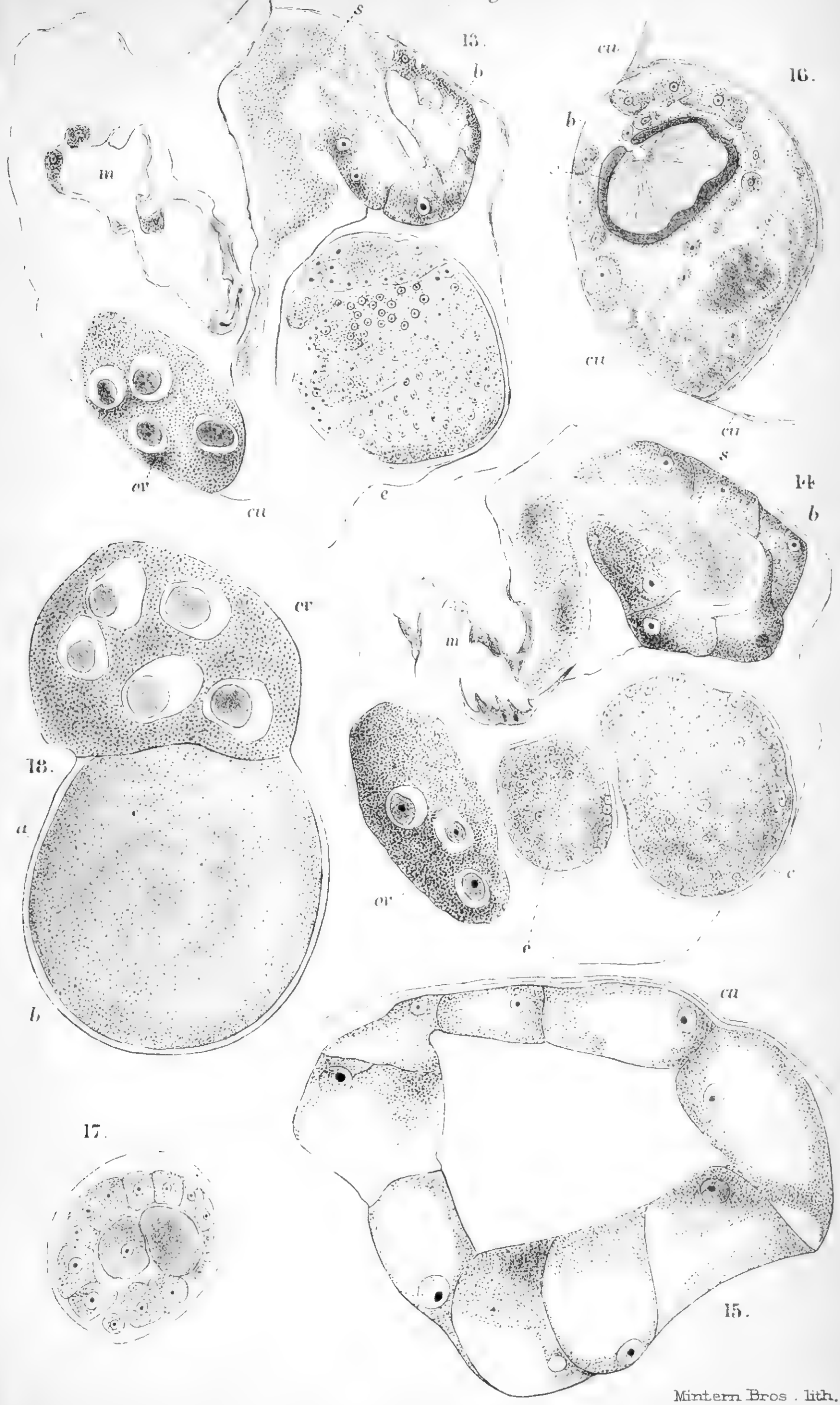

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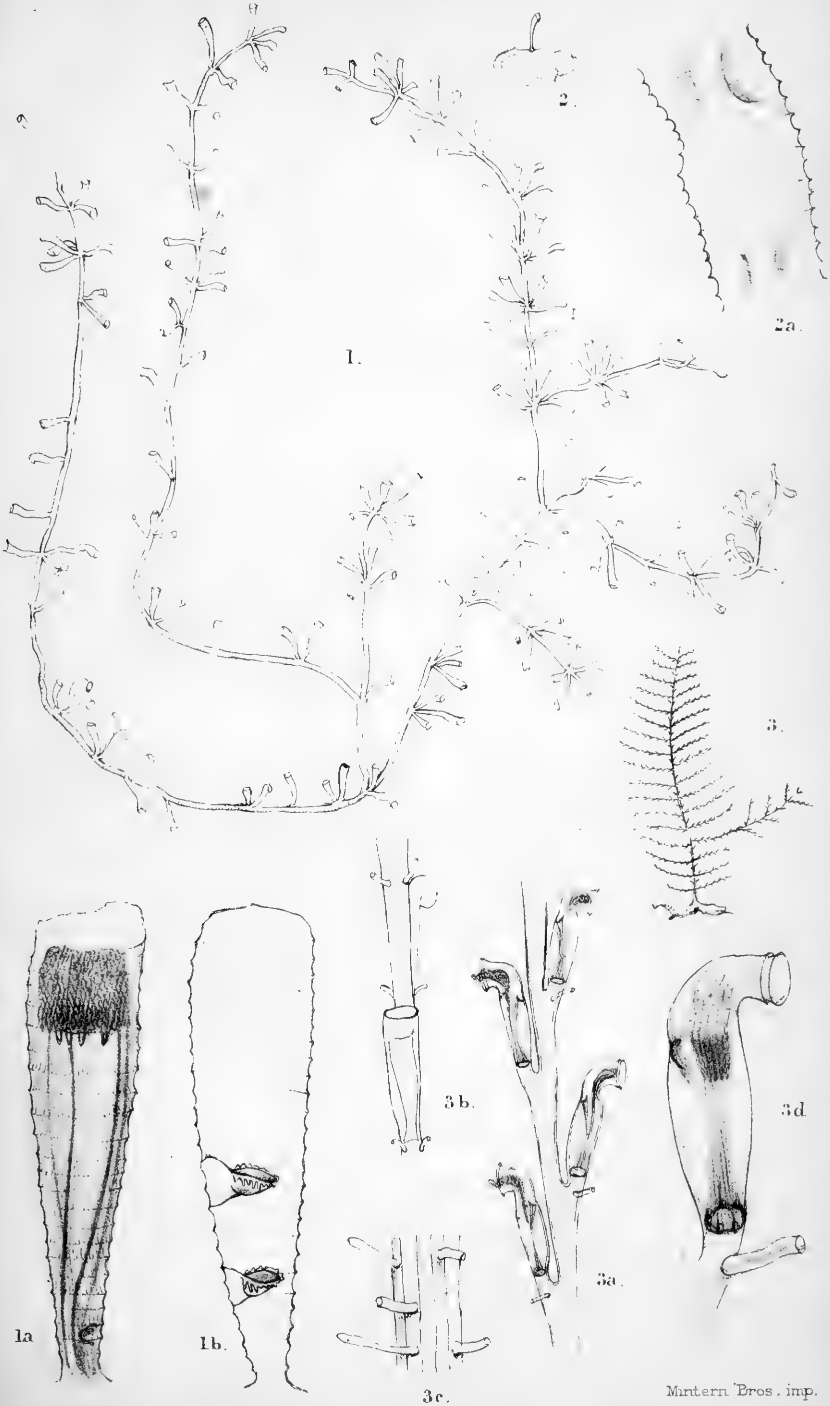

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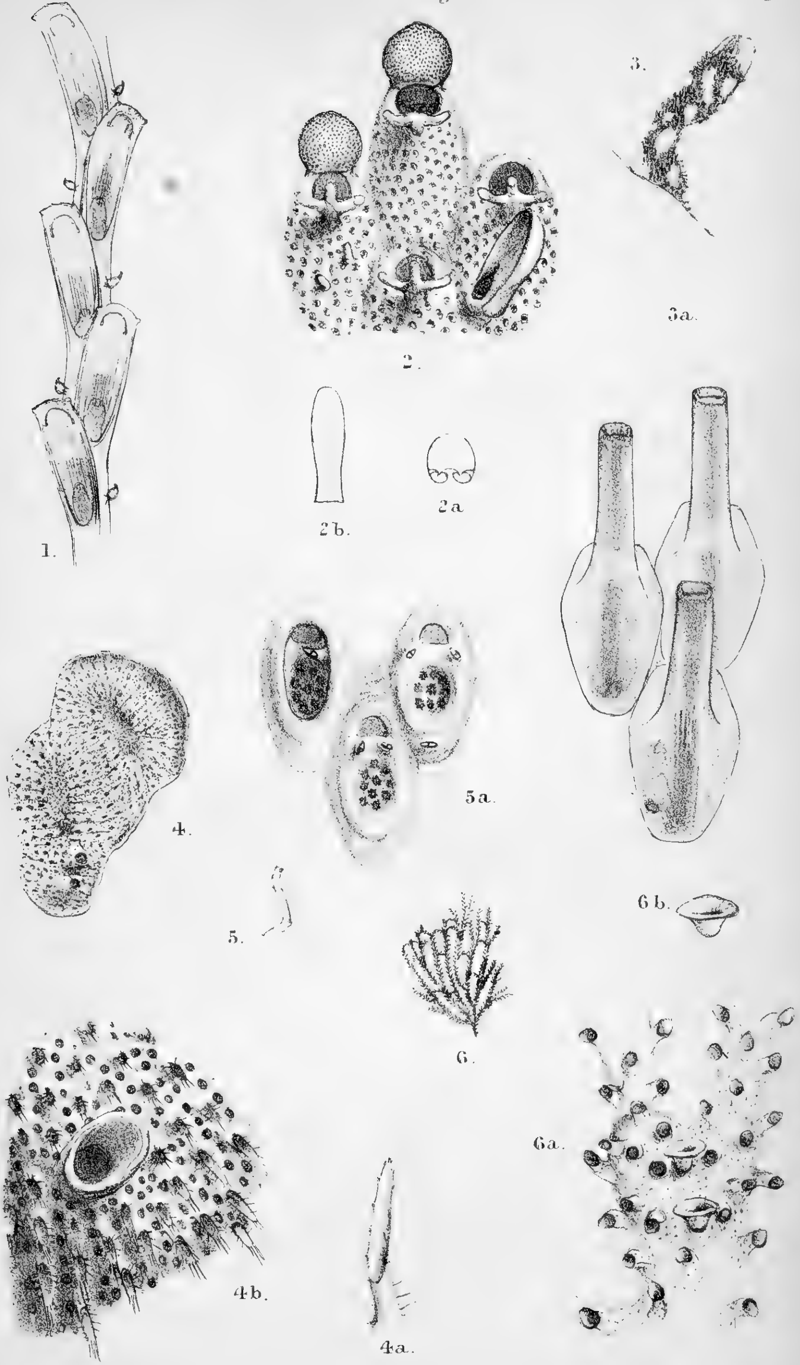

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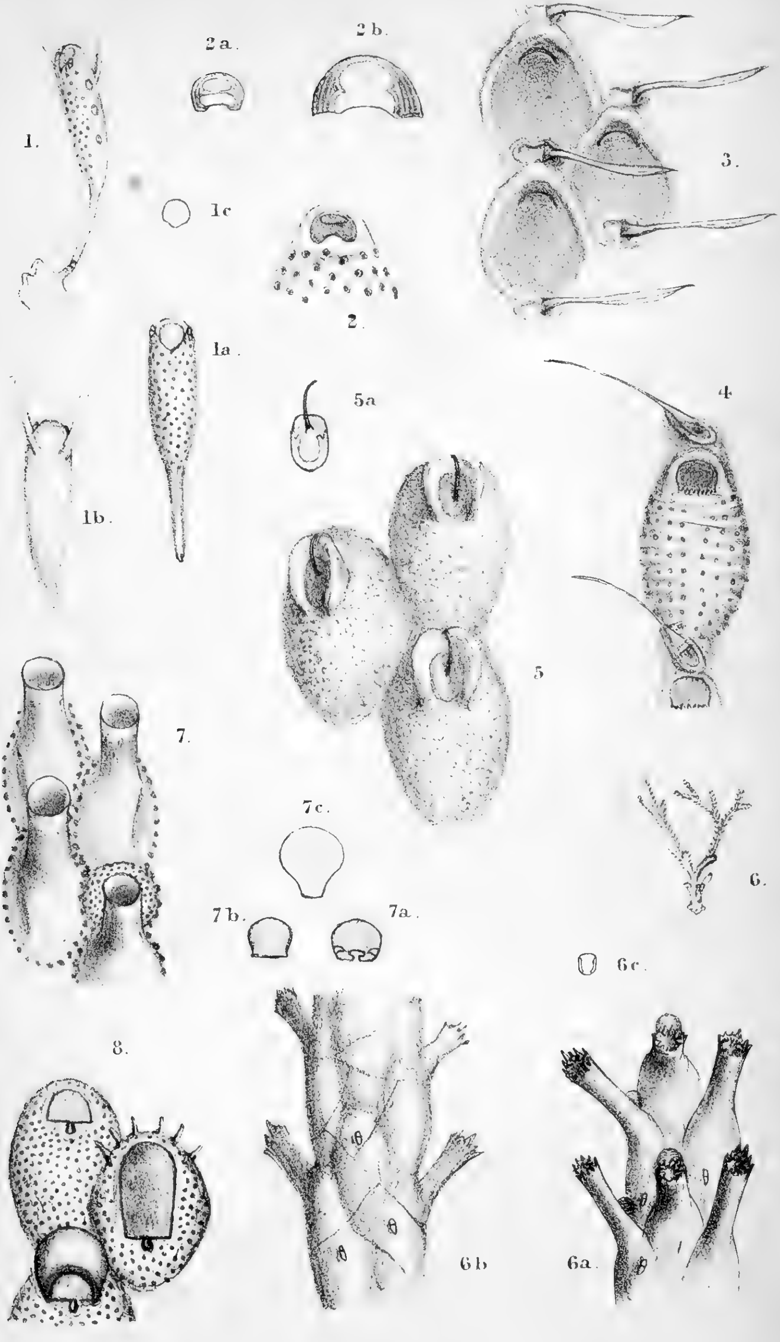

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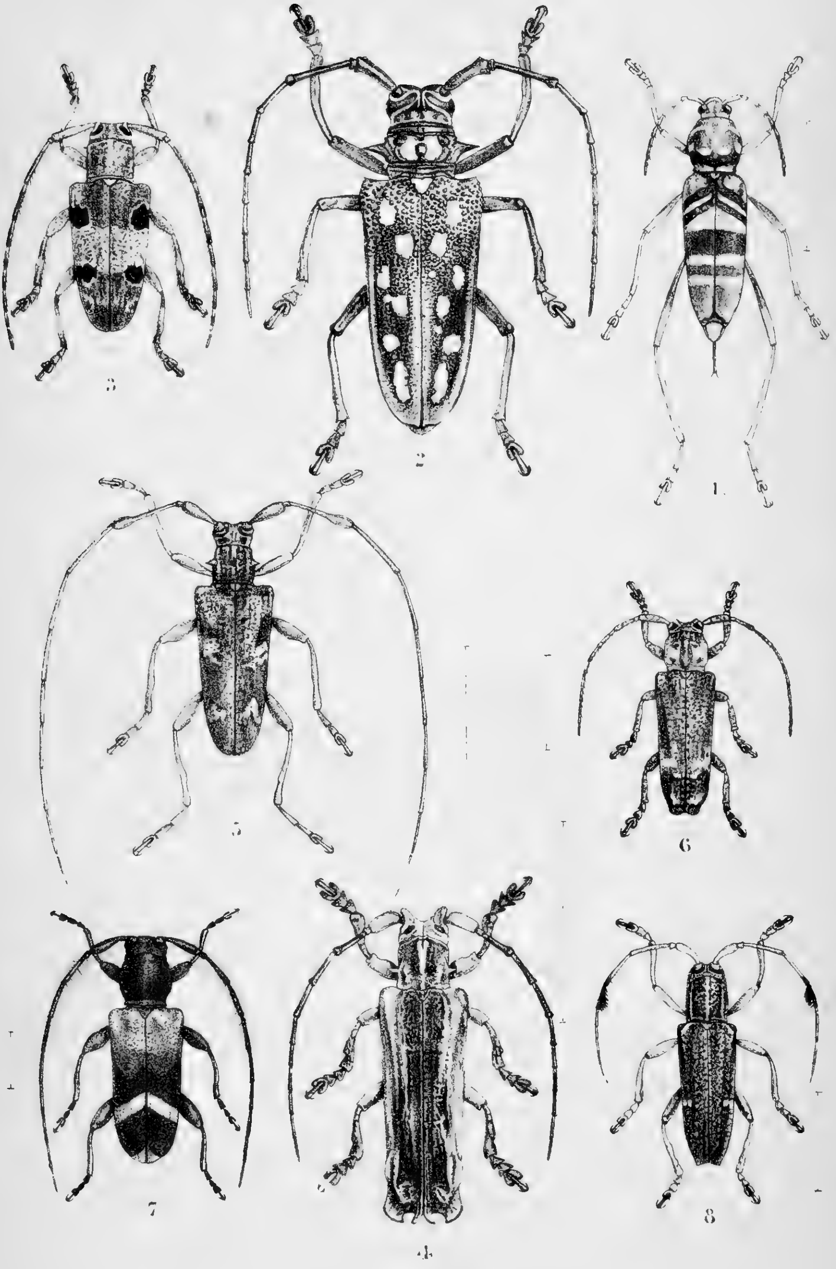
CHAMÆLEON WILLSII



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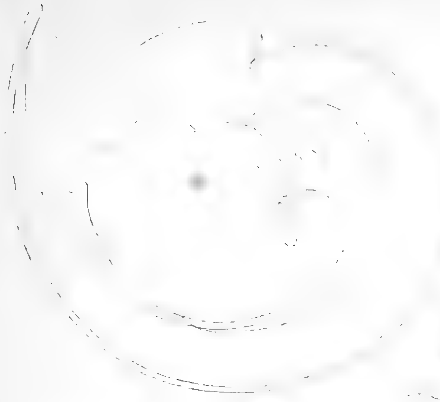
Ann. & Mag. Nat. Hist. S. 6. Vol. 5. Pl. VIII.

3.



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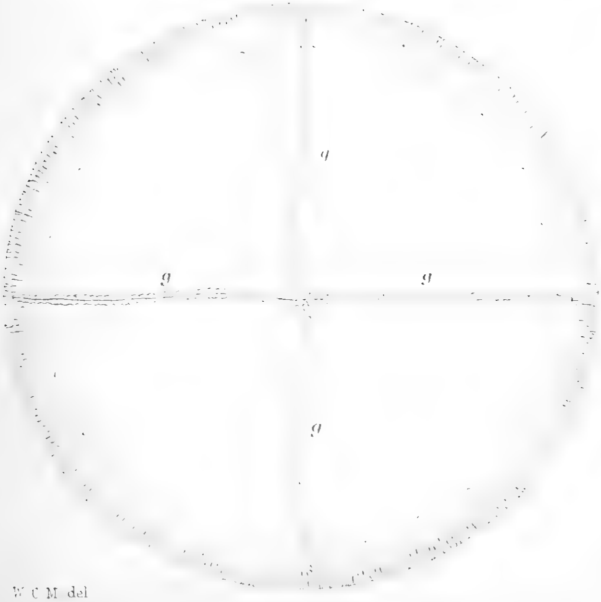

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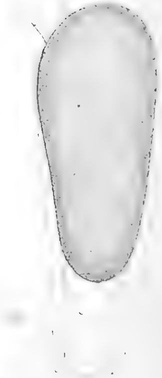

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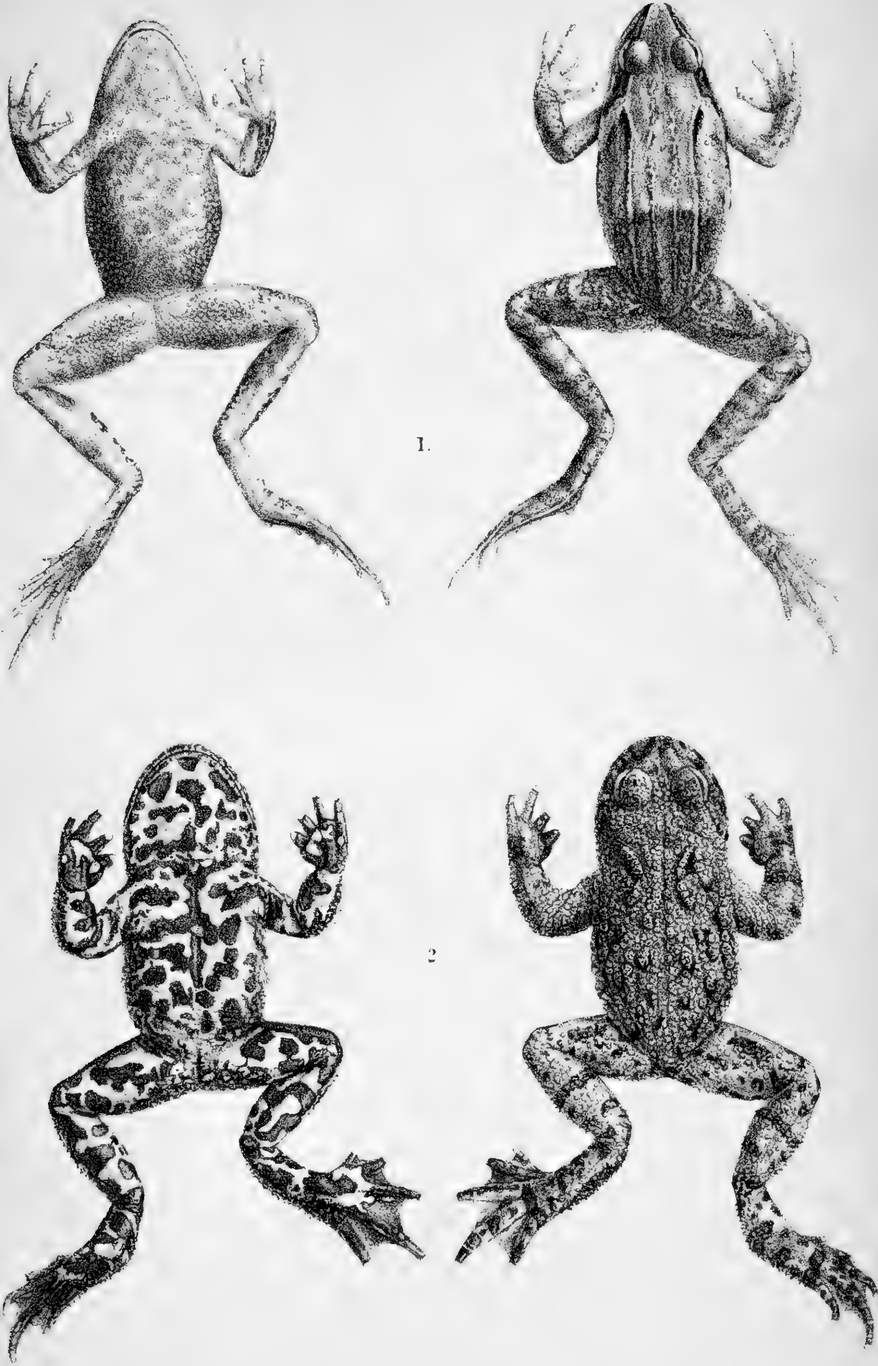


R. Mintern del. et lith. Mintern Bros. imp.

1. *Rana amurensis* 2. *Bombinator orientalis*.

Fig. 1.

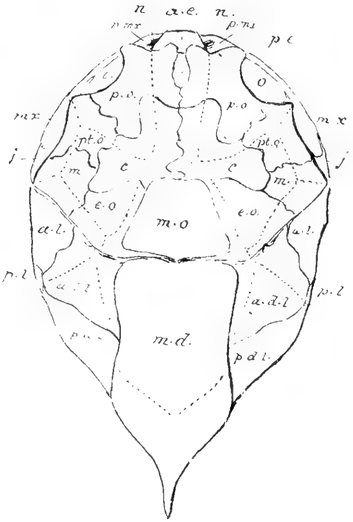


Fig. 2.

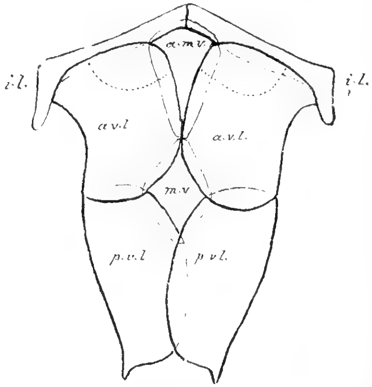
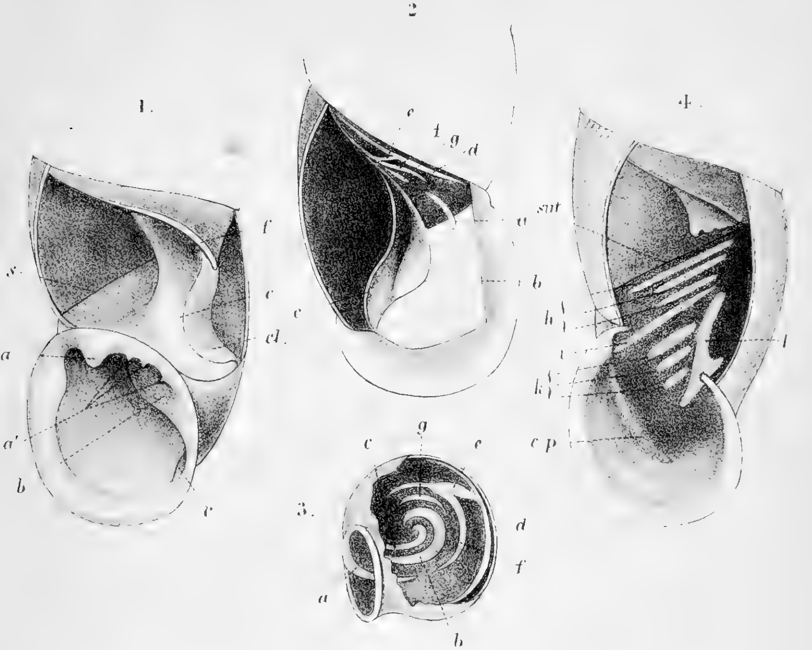


Fig. 3.

R. H. Traquair, del

McFarlane & Erskine, Lithrs Edinr

A.



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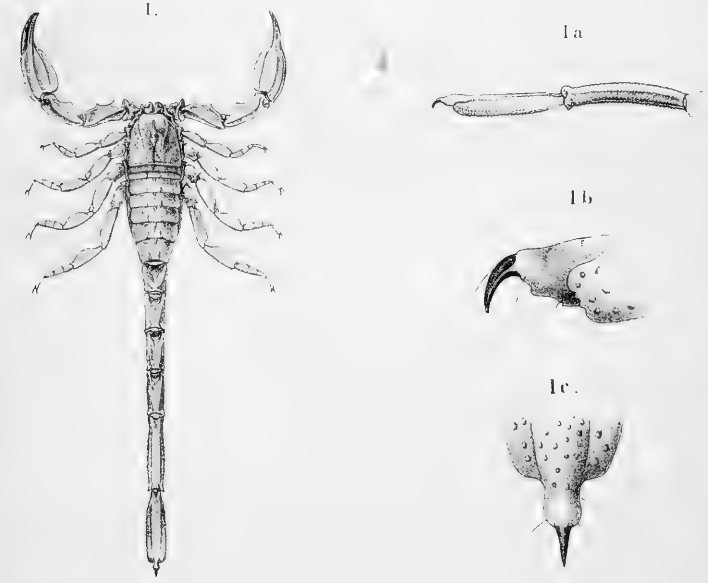

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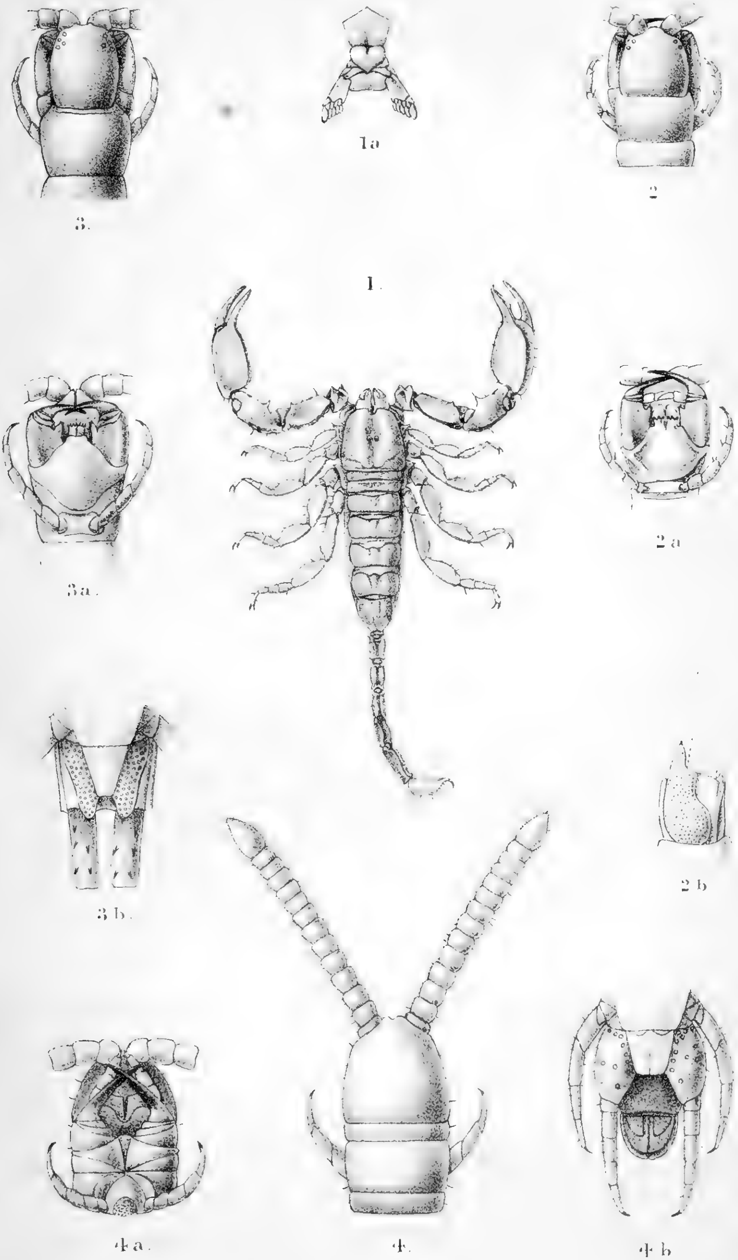

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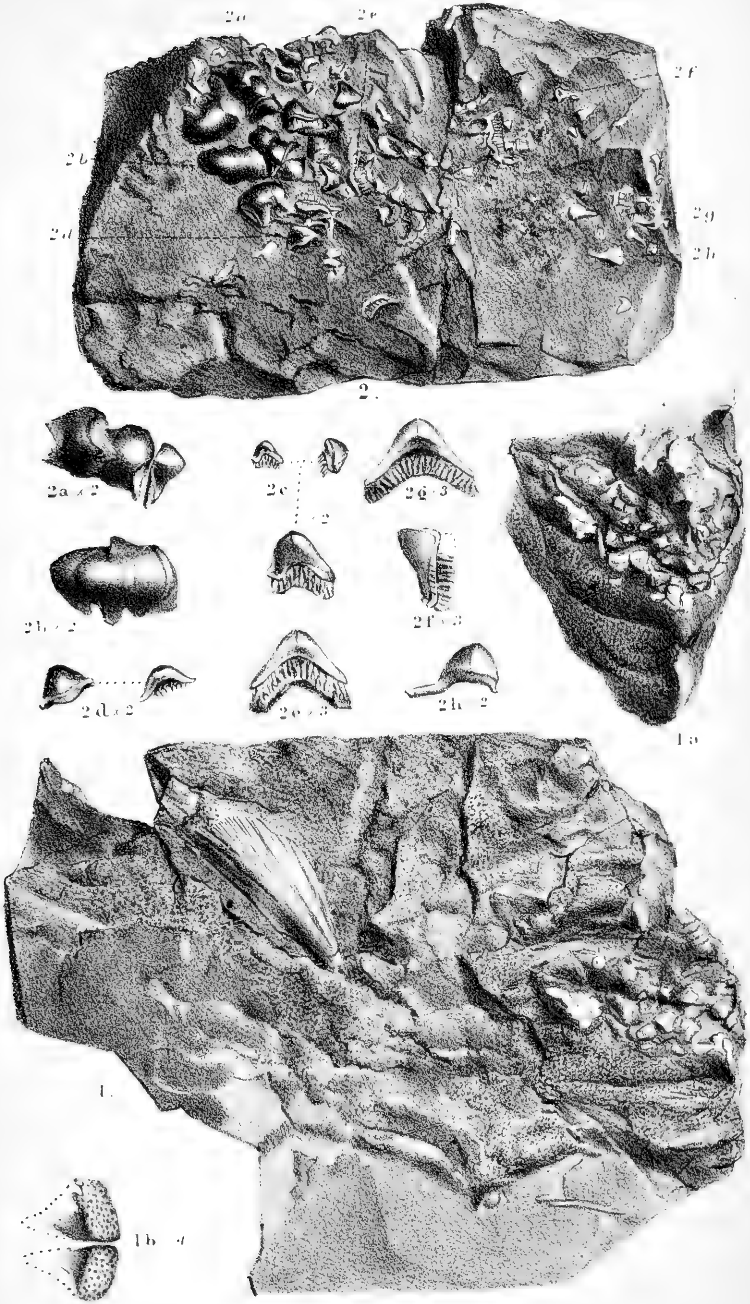
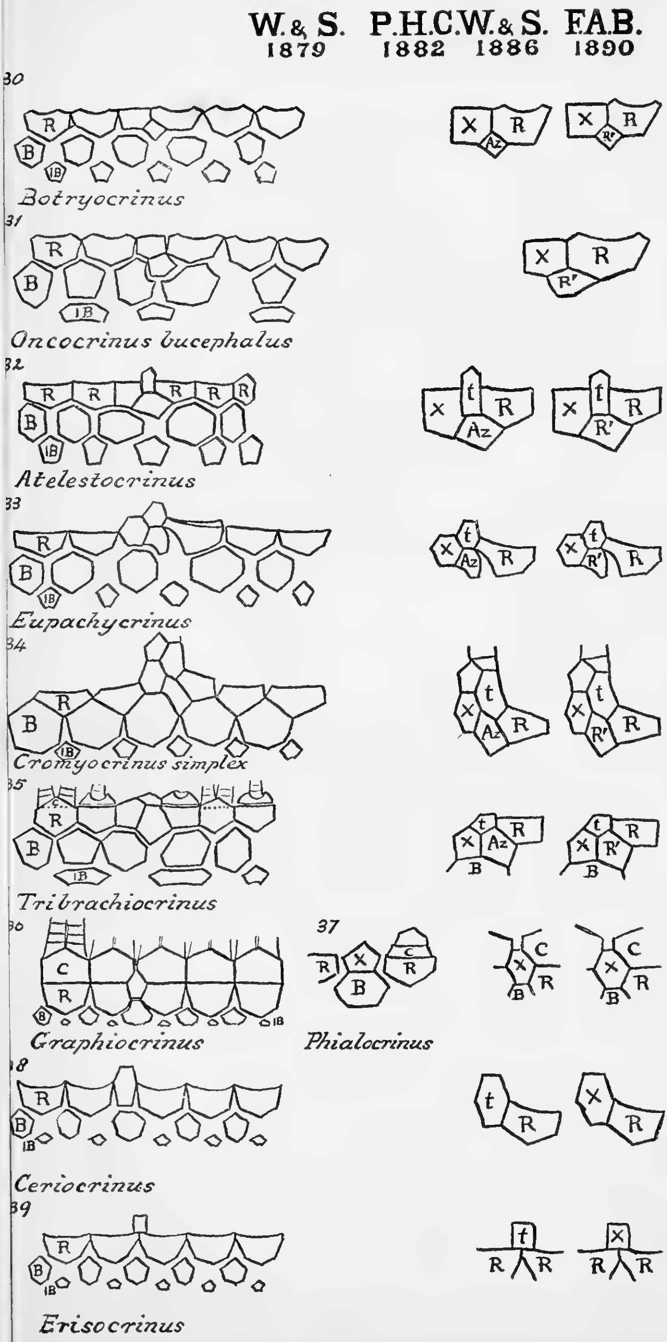


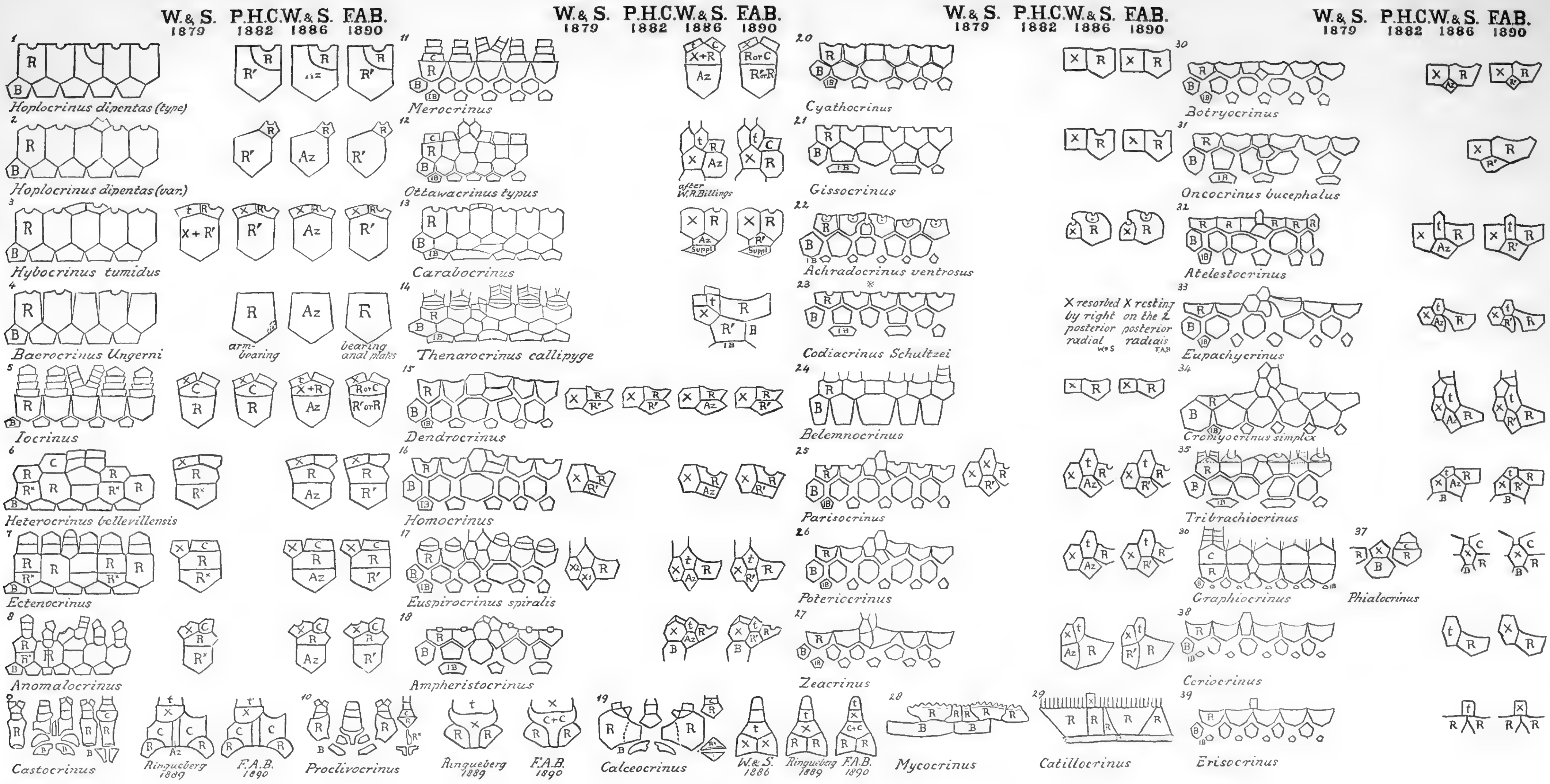
W. H. Crowther del. et lith.

Mintern Bros. imp.

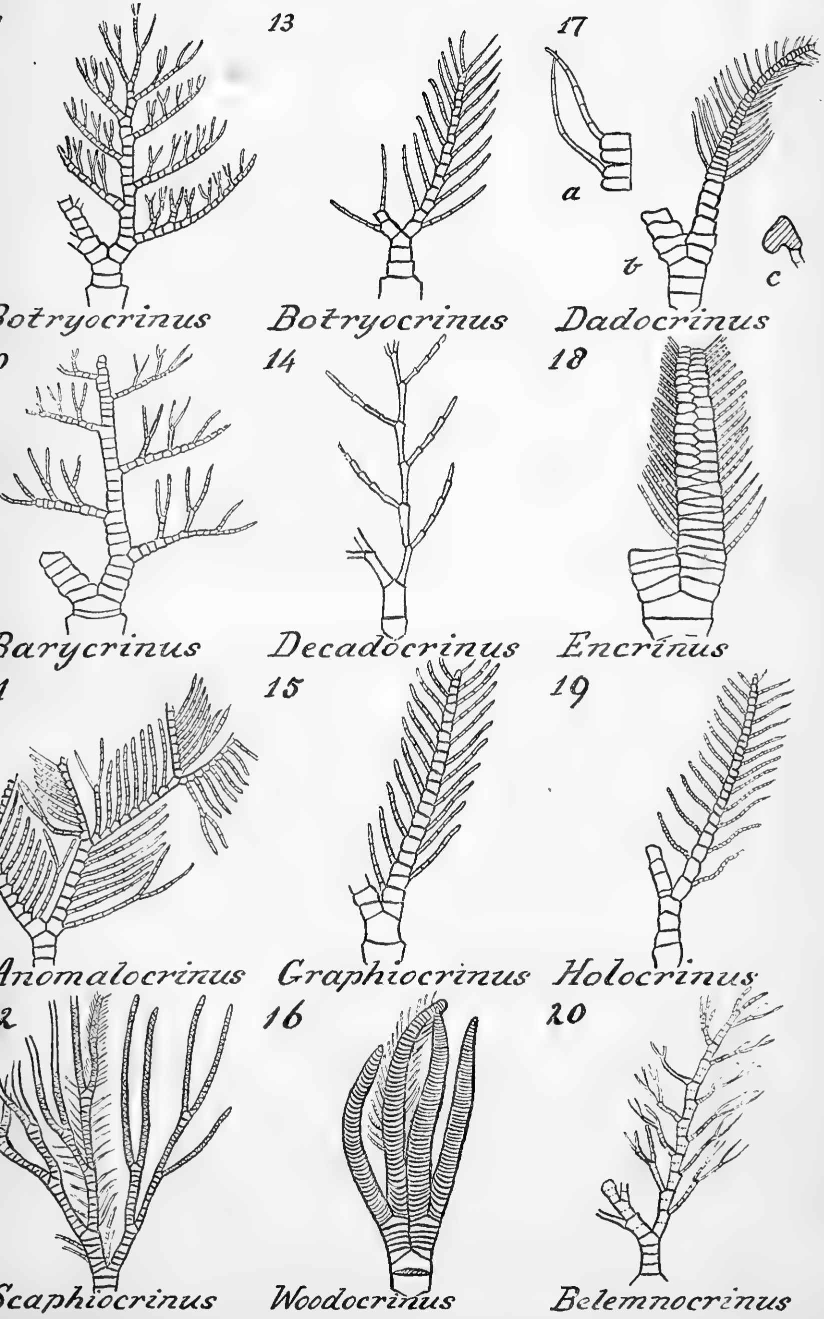
DENTITION OF PLEURODUS


W. & S. 1879
P.H.C. 1882
W. & S. 1886
F.A.B. 1890
30
Botryocrinus
31
Oncocrinus bucephalus
32
Atelestocrinus
33
Eupachycrinus
34
Cromyocrinus simplex
35
Tribrachiocrinus
36
Graphiocrinus
37
Phialocrinus
38
Ceriocrinus
39
Erisocrinus

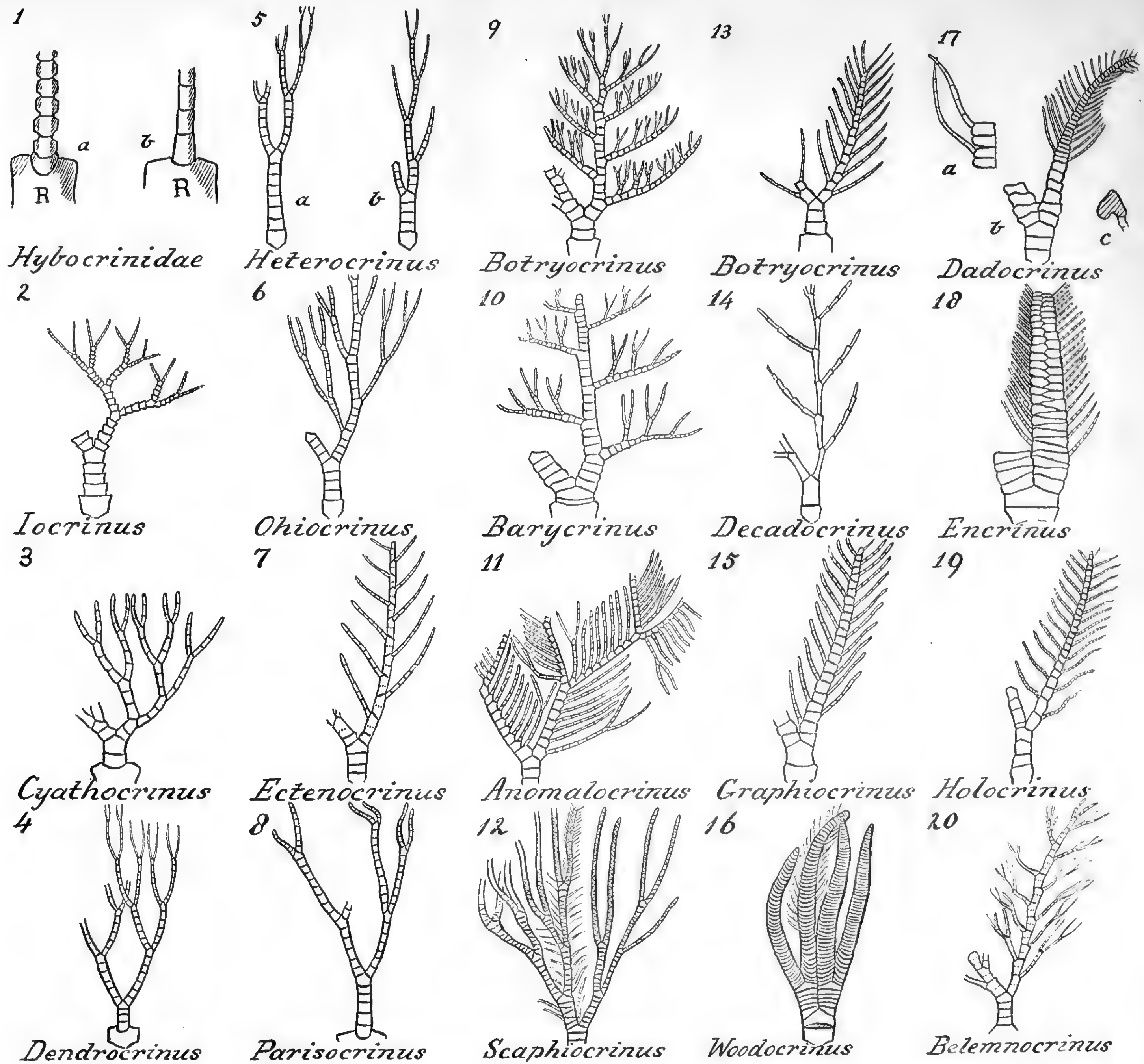
GENERA OF FISTULATE CRINOIDS.

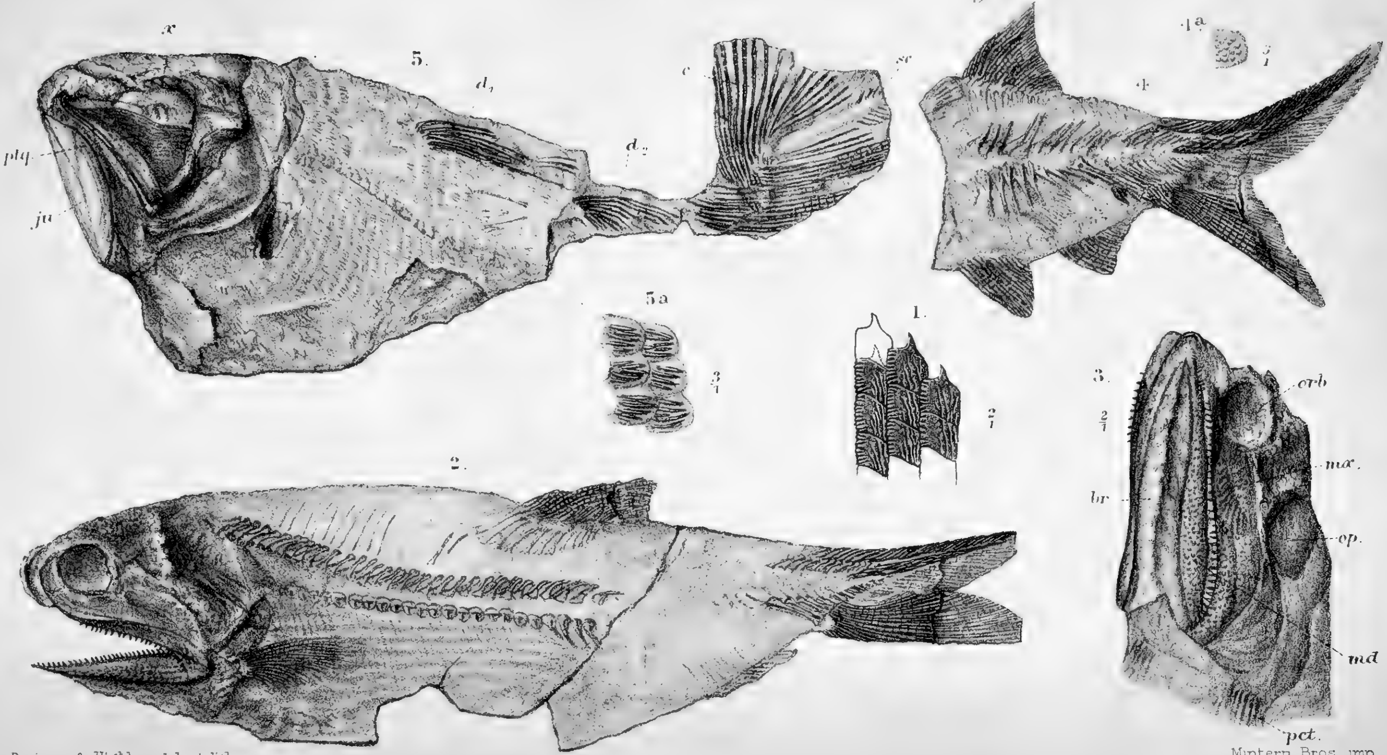


STRUCTURE IN FISTULATA.



TYPES OF ARM-STRUCTURE IN FISTULATA.



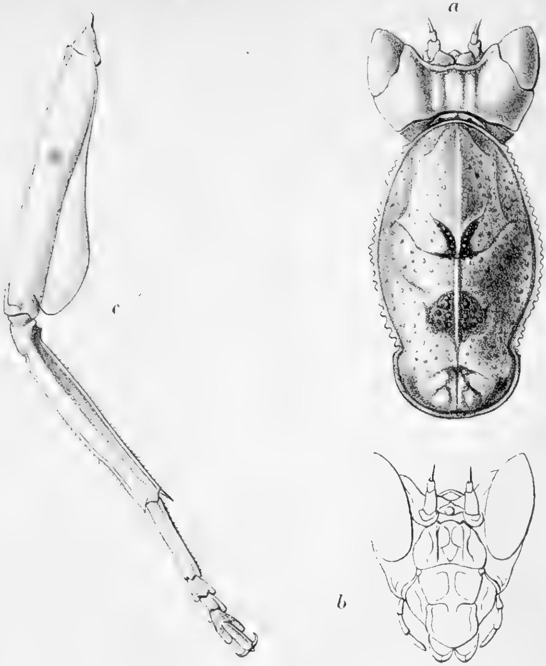


Berjeau & Highley del. et lith.

Mintern Bros. imp

1. *Centrolepis asper.* 2–4. *Coccolepis liassicus.* 5. *Undina barroviensis.*

A



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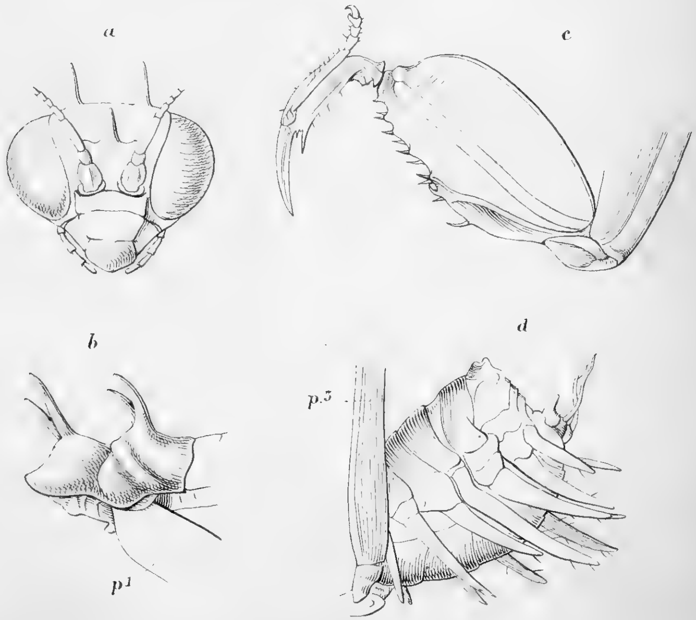

Mintern Bros. lith.