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THE

JOURNAL

OF

THE LINNEAN SOCIETY.

ZOOLOGY.

VOL. XVII.

LONDON:
SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON HOUSE,
AND BY
LONGMANS, GREEN, READER, AND DYER,
AND
WILLIAMS AND NORGATE.
1884.

Dates of Publication of the several Numbers included in this Volume.

No. 97,	pp.	1– 40,	published	March 24, 1883.
,, 98,	,,	41–108,	,,	April 17, 1883.
,, 99,	,,	109–174,	,,	July 31, 1883.
,, 100,	,,	175–269,	,,	August 14, 1883.
,, 101,	,,	269–346,	,,	October 20, 1883.
,, 102,	,,	347–394,	,,	February 29, 1884.
,, 103,	,,	395–456,	,,	September 18, 1884.

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

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ERRATA.

Page 309, line 15 from bottom, *for* " columella-wall " *read* columella well developed.

— 319, line 9 from top, *between* " 8 " *and* " oblique " insert *Lophoseris.*

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On Cerebral Homologies in Vertebrates and Invertebrates.

By Professor Owen, C.B., F.R.S., F.L.S., &c.

[Read November 16, 1882.]

In a study of the homologies of the Divisions of the Vertebrate brain with Nerve-centres in Invertebrates, the subjects of comparison should be the best-developed anterior and special-sense masses in the latter and the least-developed ones in the former subkingdom.

In many Fishes—*Lepidosteus*, *Anguilla*, e. g.*, the neural masses in direct relation to nerves of special sense are as large as, or larger than, those not so related bearing the names of "cerebrum" and "cerebellum," these being the homologues of those centres which receive, in higher Vertebrates, such vast accessions of grey and white neurine as to represent, or seemingly compose, the whole organ known as the "brain" in man and most mammals.

The chief accumulation rises and expands from the parial nerve-tracts or "crura" between those portions of the tracts which, in front of the cerebral hemispheres, develop the masses or ganglia related to the sense of "smell" and those behind the hemispheres, related to the sense of "sight." Next in retral succession are enlargements related to the sense of "taste" and

* 'Anatomy of Vertebrates,' 8vo, vol. i. (1866) p. 275, figs. 174, 175.

to movements of parts of the mouth; behind the "trigeminal" centres are those subserving the sense of "hearing;" above these centres rises the "cerebellum."

Thus the central masses of the neural axis in relation to the "special senses" run in longitudinal sequence from before backward, and might be called the "ganglions" of smell, sight, taste, and hearing.

These several sense-centres are not in contact with one another in all Vertebrates. The olfactory ganglia are connected by long cords with the optic ganglia in many fishes (Cyprinoids *e.g.**). The tracts intercommunicating with the trigeminal lobes recall the corresponding ones known as "œsophageal cords" in Mollusks and Insects. Short and thick in all Vertebrates are the tracts of the macromyelon, or "medulla oblonga," connecting the gustatory with the auditory nerve-centres; but all such centres, with superadded masses, are reckoned parts of the "brain."

The condition which affects the length and tenuity of the tracts connecting the optic (diagram, p. 13, *a f*) with the oral (ib. *b*) nerve-centres in Invertebrates is the course of the alimentary canal (ib. *c l*) neurad†, along the interspace between the foremost and the next neural centres.

The elongated homologues of the vertebrate "crura cerebri" are termed by Lyonnet, with sound homological views, "conduits de la moelle épinière"‡; by later anatomists, rejecting his views, "œsophageal cords" or "commissures."

In illustration of the present suggestions of the homologies in question, I propose to take, from the group of Arthropods, the nervous system of the Locust§.

The first, commonly foremost, neural mass (diagram, *a*), which, by the course of the œsophagus, *c*, in Mollusks and Articulates, is turned to the hæmal aspect of the alimentary canal, is that

* *Tom. cit.* p. 275, figs. 177, 178.

† *Ib.* p. 276, fig. 179 (*Chimæra*). See also fig. 3, "On the Homology of the Conario-hypophysial Tract," Journal of the Linnean Society, Zoology, vol. xvi. p. 135.

‡ 'Traité anatomique de la Chenille qui ronge le bois du Saule,' 4to, 1762.

§ As represented in *Caloptenus femur-rubrum*, *C. spretus*, and *C. bivittatus*, by the exemplary dissections and microscopic sections by MM. Burgess and Mason, described and figured by Prof. Packard in the 'Second Report of the U.S. Entomological Commission,' 1880, pp. 223–242, pls. ix.–xv.

which is usually designated the "supraœsophageal ganglion," or, after Lyonnet and Cuvier*, "the brain."

This consists of a pair of neural masses, or "hemispheres," confluent mesially for one half of their longitudinal extent, before and behind which confluent tract they are free. Each moiety presents three lobes or enlargements, the smallest of which receives the antennal nerve, *e*, a second, the largest, the optic nerve, *f*, the third the ocellar nerve, *g*†. From the œsophageal surface of each moiety proceeds the tract or "commissure," *d*, which, traversing its own side of the gullet, converges to and, with its fellow, expands into the neural mass termed the "subœsophageal ganglion," *b*.

With this neural mass are connected by origin or insertion the nerves to the "trophi," *i. e.* the labrum, the mandibles, the maxillæ, the labium with its tongue-like extension, and the sense-organs called "maxillary" and "labial palpi," together with the complex muscles of these several parts.

The properties of the vertebrate mouth, viz. taste and motions, may be reasonably assigned to the foregoing invertebrate oral organs: accordingly the nerves connected therewith, endowing the mouth with the same characteristic powers and properties for testing, seizing, and comminuting alimentary substances, I deem, with their neural centres, to be homologous with those of like endowments in the vertebrate animals.

The part of the vertebrate brain to which, therefore, the so-called "subœsophageal ganglion" in Invertebrates is analogous and, I conceive also, homologous, is the basis of the epencephalon known as the "medulla oblongata" (macromyelon), or so much of that myelencephalous tract as may be in connexion with the trigeminal and hypoglossal nerves—the neural machinery, to wit, for the sensations and motions of the parts forming or being lodged within, or furnishing secretions to, the vertebrate mouth.

Through the different course of the gullet, in relation to certain nerve-centres in Vertebrates and Invertebrates‡, a greater degree of juxtaposition and concentration of those centres connected with the special senses, and the neural mechanism relating

* "Le cerveau proprement dit," Leçons d'Anat. comparée, ed. 1845, tom. iii. pp. 305, 335.

† I omit the filaments connecting the foremost minute mesial ganglion of the "sympathetic" or "stomato-gastric" system with the above cerebral mass.

‡ Linnean Society's Journal, vol. xvi. p. 135, figs. 2 and 3.

to the reception of their impressions, is possible in the group in which the "brain," or sum of such centres, is not traversed by the alimentary canal.

We are thus prepared for the conception that, as the oral nerve-centres in Invertebrates are so far removed from the narial nerve-centres, so the ear-organs and their centres may be correspondingly remote from the oral ones.

Johannes Müller recognized a structure in the fore leg of the *Gryllus hieroglyphus*, which von Siebold detected in other Orthoptera; and this structure was by both regarded as the true seat of the auditory sense. The vesicle, in connexion with a *quasi* tympanic membrane closing an orifice in the fore leg, receives two unusually large nerves from the foremost "thoracic ganglion," *o*; these nerves accompany the tracheal branch of the vesicle; the lesser nerve attaches itself to the vesicular dilatation, and there expands into a flattened tract, displaying a structure akin to that of the acoustic-nerve lining of the semicircular canals in Vertebrates. This interpretation is accepted by the experienced anatomist of the Arthropoda, Prof. Packard, who writes:—"In the green Grasshoppers, such as the *Katydes* and their allies, whose ears are situated in their fore legs, the 'first thoracic ganglion' is a complex one"*, such "auditory nerves" communicating therewith.

Although, physiologically, the remoter neural mass may be compared with the part of the epencephalon in connexion with the auditory organ, it may be too much to look for consent to a corresponding homology. And, if such be denied, yet the retral transfer of a sense-character beyond the gustatory one to the foremost or even a remoter thoracic nerve-mass may not, consequentially, affect the grounds for homologizing both the so-called "supra-" and "subœsophageal" ganglia, which are constant in regard to their special sense-nerves, with the parts of the vertebrate brain similarly distinguished by relations to nerves of special sense.

Conclusions counter to these homologies either limit the term "brain" to what is called the "supraœsophageal ganglion" in Invertebrates, or, more consistently, involve a negation of the homology of any part of the central neural system in Invertebrates with any part of that system in Vertebrates.

* 'Second Report' &c. p. 225.

The latest neurotomist of the Arthropoda, for example, concludes, emphatically, as follows:—"It should be remembered that the word "brain" is applied to the compound (supraœsophageal) ganglion simply by courtesy and as a matter of convenience, as it does not correspond to the brain of a vertebrate animal, the brain of the horse or man being composed of several distinct pairs of ganglia. Moreover, the brain and nervous cord of the fish or man is fundamentally different, or not homologous with that of the lower or invertebrate animals." "The nervous cord of the insect consists of a chain of ganglia connected by nerves or commissures"*.

The "nervous cord" here signifies the central tracts—ganglionic or otherwise—occupying in Invertebrates what is held to be, and is described as, the "ventral region" of the body-cavity.

The structural phenomena cited in support of the foregoing negation are:—"The entire brain of an insect is white, as are all the ganglia"†; while "the spinal cord of the fish or man consists of two kinds of substances or tissues, called "grey" and "white substance"‡.

But the associated microscopical investigators and manipulators, Burgess and Mason, found in the "entire brain" (my "fore brain" or "hæmœsophageal centres," *a*):—"I. An outer, slightly darker, usually pale greyish-white portion, made up of 'cortical cells'"‡; and "II. The medullary or inner part of the brain consists of matter which remains white or unstained after the preparation has remained thoroughly exposed to the action of carmine. It consists of minute granules and interlacing fibres. The latter often forms a fine irregular network enclosing masses of finely granulated nerve-matter"§.

Remembering the transposition of the grey and white neurine in different parts of the vertebrate neural axis, I cannot give the value to a similar transposition in parts of the invertebrate neural axis which Professor Packard assigns thereto.

The eyes of the Cuttlefish are the homologues of those of the Lump-fish, as are the optic nerves and the cerebral mass superadded, in both, to the centre receiving the impressions of those nerves. Such homology legitimately extends from Cephalopods

* Packard, 'Second Report' &c., p. 224.
† *Ib.* p. 224.
‡ *Ib.* p. 226.
§ *Ib.* p. 227.

to the Invertebrates in which a homologue of the vertebrate hemispheres may not be so largely developed or superadded.

Accordingly I conclude that the collective neural centres and their intercommunicating tracts in Invertebrates are the homologues of those centres and tracts called " brain and spinal cord " in Vertebrates, and that such " neural axis " marks, in both grades of the animal series, the same position in the body, and the same local relations to the vascular centre, *m*, and the alimentary canal, *l*. As a corollary, the neural axis, or " ganglionic cord " in Arthropods (*b o n*) denotes the neural position, and supports the inference that its foremost portion, *a*, is simply displaced by the course of the gullet through the brain in order to open by a mouth upon the neural aspect of the body. The suppression of such transcerebral tract in Vertebrates allows the continuation of the alimentary canal forwards to an oral opening on the hæmal aspect of the body. Here the œsophagus offers no obstacle to the approximation of the main cerebral centres to each other—the fore brain to the hind brain. Hence that juxtaposed allocation of the primary encephalic divisions, associated with the progressive accumulations of grey and white neurine, which the cerebrum and cerebellum present, in relation to the centres subservient to the ingoing conductors of sensations and the outgoing ones of motions, as we pass in their contemplation from the fish to the ape and the man.

The so-called " brain " in the Locusts answers to a part only of the brain of a fish; moreover it is not a " supraœsophageal ganglion," but a " sub " or " hæmœsophageal " one.

The next neural mass in the brain of the Locust (*b*) answers to the epencephalon of the fish; it is not a " subœsophageal ganglion," but a " supra-" or " neurœsophageal " one, and the foremost of that series of the neural centres or " ganglions."

The homologue of the vertebrate myelon in Invertebrates is not protected by a special bony case or " vertebral column." The " ganglionic cord " is nevertheless the most precious, as it is the most delicate and crushable of an insect's organs. Hence it has been, so to speak, ordained that the part of the body's surface to which the neural axis is nearest should not be, as in the beast, along the part most exposed and liable to blows. By a modified flexure of the limb-segments the trunk of a beetle or lobster is turned so as to hold the same relative position to the ground as does the part of the beast's body least exposed to injuries.

The aspects of the trunk in locomotion are no primary or essential characters of a natural group. Some insects, indeed, swim with their neural surface upwards, as does the fish.

Active *Bimana*, in the aspects of the trunk, differ from both beasts and beetles: when a man stands, his body is at right angles to the ground, and the limbs are in the same line with the trunk. But the heart in man indicates the "hæmal" aspect, the myelon the "neural" aspect, as in the animals of lower grade, whether vertebrate or invertebrate.

The restriction by Cuvier of cerebral homologies to the so-called "supraœsophageal ganglion" in the latter zoological division leads me to add a few remarks on what may be derived from the molluscous subkingdom in illustration of my present subject. In this group, indeed, the great anatomist admitted an exception in favour of the highest Cephalopoda *.

In fact, the encephalon in the Dibranchiate order resembles that of Vertebrates in the mutual proximity of the "fore" and "hind brains;" so approximated, they are both also protected partially by a cartilaginous case which, with some histological modification, is analogous to, if not homologous with, the vertebrate cranium.

But the cephalopodic brain retains the invertebrate condition of giving passage to the gullet along the tract or part answering to the third ventricle; only the lateral boundaries or crural tracts are much shorter and thicker than in inferior Mollusks or in Articulates.

Still it is plain that the nervous mass on one side of the gullet answers to the "supraœsophageal ganglion," and that on the opposite side to the "subœsophageal ganglion" of lower Invertebrates.

The latter, in Cephalopods, sends off the acoustic nerves, and is continued into the cords which endow the muscles and skin of the trunk with the motory and sensory powers. A closer resemblance than is usually seen in Invertebrates to the Vertebrate myelon is moreover manifested by the conspicuous ganglions developed on the sensory tracts or cords of the trunk†, and the non-ganglionic continuation of the motory division of the body-cords continued from the Cephalopod's brain.

* *Op. cit.* tom. iii. p. 297.

† 'Anatomy of the Pearly Nautilus,' 4to, 1832, p. 38, pl. 7. fig. 3.

From the beginning of the short and thick side tracts which indicate, if they do not represent, the parts of the vertebrate brain intervening between the "pros-" and "epencephalon" the large optic nerves are given off. I need not repeat their well-known characters and developments in relation to the large and complex eyes of the Dibranchiates.

Beyond the origin of the optic nerves each side tract terminates in a "subœsophageal" mass, divided into two portions and supplying the parts corresponding with those in Vertebrates which send and receive their nervous influences through the "medulla oblongata" (macromyelon) and the "spinal cord" (myelon).

The dibranchiate homologue of the supraœsophageal ganglion moreover supports a part of the vertebrate cerebrum, less manifestly, if at all, shown in other Invertebrates; it is a superposed mass of a whiter colour than the rest of the encephalic centres, with an indication of a division into a lateral pair of lobes, and, in *Sepia*, presenting a subtriangular form with the apex anterior. From the deeper-seated part of the "supraœsophageal" mass are sent off, besides smaller filaments, a pair of nerves, or "crura," which converge and are lost in a more anterior ganglionic mass —the "ganglion sus-buccal," or the superoral ganglion, of Cuvier —which distributes nerves to the delicate membranous folds and processes developed from the interspaces of the cephalic arms, and to the plicated and papillose lips which surround and project anterior to the beak, and which soft and lubricous parts we may reasonably suppose to receive from their superœsophageal, or cerebral, centres the faculty of judging of the odorous qualities of the substances to be seized by the beak.

From the anterior portion of the larger "subœsophageal" mass are sent off nerves to the rasping and gustatory organs within the mouth, and the larger nerves which supply the eight cephalic acetabuliferous arms and tentacles. From the posterior division of the subœsophageal mass are sent off the moto-sensory nerves of the trunk already noticed, and also visceral nerves *.

In the Tetrabranchiate Cephalopods the foregoing primary divisions and functions of the brain are simplified, and so are more clearly manifested. The cartilaginous defensive case protects only the homologue of the "sub-" or, rather, "neurœsophageal"

* 'Memoir on the Pearly Nautilus,' 4to, 1832, p. 37, pl. 7. fig. 3.

ganglion, which is more distinctly divided into a fore and hind mass. The first of these supplies the anterior or cephalic muscular and tegumentary parts, the second the posterior or corporal ones; and from this division or cerebral centre are derived the nerves of the acoustic organs developed or imbedded in the corresponding supporting cartilage*.

The super- (hæm-)œsophageal body develops no peripheral lobe, is in the form of a thick cord which sends forward nerves to oral parts suggestive of an olfactory function, and, laterally, the large short cords, swelling into ganglions, subserving the retinal supply of the pedunculate eyes.

The brain-space traversed by the gullet is wider than in the Dibranchiates, the annectant tracts between the "supra-" and "subœsophageal" masses are longer; but their resemblance to the œsophageal cords in the Articulates is still closer in the modifications of the cephalopodal type of the nervous system, especially of its encephalic centres, which are seen in *Aplysia* and all lower Mollusca.

And here I need only to refer to the rich series of monographs on this branch of comparative neurology, for which we are indebted to our fellow Member and labourer Mr. Robert Garner, of Stoke-upon-Trent †, still in enjoyment of health and intellectual vigour; also to another, whose loss we lament, the late Dr. Albany Hancock, F.R.S.‡

In his admirable researches on the Nervous System of Insects, Newport§ discovered that "the nervous cords between the ganglia included two columns," and that "the *inferior* column alone goes to the formation of the ganglia, whilst the *superior* lies upon them without any perceptible enlargement." Upon this he founded his distinction of the "motor" and "sensitive" columns in Insects as in Vertebrates. This, of itself, must weigh in the question of the homology of the ganglionic cords of Articulates with the myelon of Vertebrates; and acceptors of such homology gain by a determination of the corresponding surfaces

* Macdonald, Anat. of the *Nautilus umbilicatus*, Phil. Trans. 1855, p. 279.

† See his beautifully illustrated memoirs in the Transactions of the Linnean Society, vol. xvii. (1837), and in the Transactions of the Zoological Society, vol. ii. (1835).

‡ By monographs in the publications by the Ray Society, in the 'Annals of Natural History,' and in the 'Philosophical Transactions,' with his associate workers Embleton and Alder.

§ Philosophical Transactions, 1843, p. 243.

of the entire frame in the two groups. If the ganglionic cord be the homologue of the myelon, the surface of the body next to which those nerve-centres respectively extend must be the same. If such surface be turned downward in the ordinary station and progression of an Insect, the columns on which the sensory ganglions are formed will be "inferior;" while in Vertebrates, according to the position in which the body may be carried, the ganglionic or sensory columns will be "superior" in the beast and "posterior" in the man. Terms, therefore, defining aspect and position independent of the accident of limb-direction, should be acceptable: "neural" and "hæmal" are as applicable to parts as to wholes.

A heart, whether compact or elongate, has a surface looking toward the "neural aspect," and a surface with an opposite aspect. One may predicate of the hæmal side of a "heart" or "dorsal vessel" whether it be at the fore side of the body (in a man), or at the under side (in a beast), or along the upper side (in an insect). So likewise with regard to the nervous axis: Newport's sensory ganglions in that of the Insect are developed in and from the cords on the "neural" side of such axis, as they are in the "neural" columns of the Vertebrate myelon, as distinguished from the "hæmal" columns.

Developmental researches may gain by such appreciation. The admirable Investigator whose recent loss morphologists deplore, thus writes:—"The embryo of *Peripatus* shows what was once part of a continuous slit running nearly its whole length;" . . . "it at first leads into the alimentary canal, like the neurenteric canal of the vertebrate embryo; but this communication is closed prior to the appearance of the first rudiments of the ventral nerve-cords"*.

The primitive streak, or slit, prior to its closure as the medullary canal, occupies the same position or aspect of the body in the vertebrate embryo as does the so-termed *ventral* position in *Peripatus*—that, namely, which in Vertebrates is called "*dorsal*" as arbitrarily as in Invertebrates it is called "ventral." It is the homologous aspect or position of the body in both.

But, to resume, my contention here is, that the homologues of the primary divisions of the brain in Mollusks are the parts known in Articulates as the "supra-" and "subœsophageal ganglions" with their commissural or annectant cords or "crura," that

* Balfour, 'Comparative Embryology,' 8vo, 1881, vol. ii. p. 312.

the topical relations of these parts to the gullet are the same in both great divisions of Invertebrates, and that the homologies of the aforesaid parts with the primary divisions of the Vertebrate brain are affected solely by the altered relation thereto of the gullet and mouth.

The homologies of the Dibranchiate brain, notwithstanding the œsophageal and oral differences and a non-appreciation of their essential nature and cause, were recognized and affirmed by the Father of the anatomy of the Mollusca. They are clearly expressed in the first of his immortal 'Mémoires'* on that subject; and are briefly summarized in the 'Leçons d'Anatomie comparée.' After describing the "sub-" and "supraœsophageal" centres, Cuvier affirms:—"On pourrait comparer le premier au cervelet, l'autre au cerveau des Vertébrés." If for "cerebellum" one writes "epencephalon," this defined correspondence of the brain of the highest Mollusks with that of the lowest Vertebrates would square with my own convictions.

But now I am driven to ask, Why did Cuvier refuse to extend his views, whether homological or analogical, of the answerable parts of the brain in Vertebrates and Invertebrates beyond the "supraœsophageal" mass or ganglion in Mollusks and Articulates? Because he declined to extend those views in relation to the Vertebrate and Invertebrate encephalic centres beyond or below the higher order of Cephalopoda; and he logically pronounced, at the conclusion of his admirable anatomical monograph of the "Poulpe" (*Octopus vulgaris*), that the class of which it was the type—my Cephalopoda Dibranchiata—formed not the passage to any other group, and that they have not resulted from the development of other animals, and that their own development has produced nothing superior to them†. It must be remembered, however, that the transitional modifications of the Tetrabranchiate Cephalopods had not at that date been made known.

If, however, the cerebral homologies may be traced, with the guidance of the Pearly Nautilus, through the still lower, more simplified Mollusca, notwithstanding their retaining more of the lower and primitive circumoral type, my next contention is that

* 'Mémoires pour servir à l'Histoire et l'Anatomie des Mollusques,' 4to, 1816, Mém. 1er, "Sur le Poulpe (*Octopus vulgaris*)."

† 'Mémoire sur le Poulpe,' *op. cit.* p. 43.

those homologies may be predicated of the modifications of the brain in the Articulata.

So plain, so obvious, indeed, seem to me the grounds for such homologies, that I should have shrunk from urging them before my fellow-labourers of this Society were not views very analogous to the restricted ones of Cuvier maintained and asserted by the accomplished and experienced comparative anatomist, especially of Invertebrate animals, in the United States, to whose valuable Monograph * I have already referred.

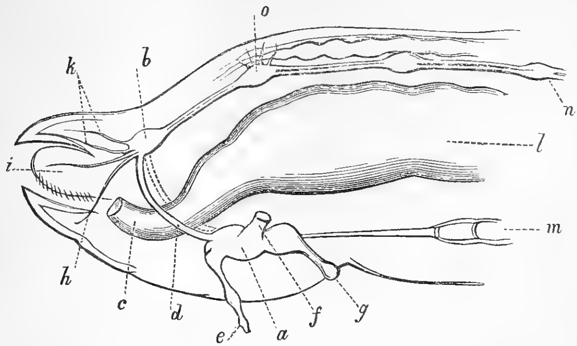
I gladly, however, welcome the alliance of my Master in predicating corresponding parts of the nervous centres in the whole series of brain-possessing animals, so far as he felt himself justified to go. And I avail myself of this concordance to define, agreeably with our common views, the aspects of the body in the adult Cephalopod, but in the terms which have been suggested by conclusions as to the essential conditions and wide extent of a possible predication of neural homologies.

The side of the body of a Cuttlefish or Squid denoted by the "neurœsophageal" ("subœsophageal" so called) brain-part, with the chief nervous extensions therefrom along the trunk, is the "neural aspect," its superficies the "neural surface." The side of the body to which the "hæmœsophageal" (so-called "supraœsophageal") brain-part has been turned by the course of the gullet is the "hæmal aspect;" its superficies is the "hæmal surface." The "narrow space enclosed by the arms, which contains the mouth," together with the entire acetabular surface of those cephalic arms, is the anterior or "oral surface," answering to that so termed in all other Invertebrates, as is the homologous part in all Vertebrates. The opposite end of the body, with its appended fins, is the posterior or caudal end; what is usually called the upper surface in adult Cephalopods, as in all lower Mollusks and in Articulates, is the "hæmal one;" the opposite surface is the "neural" one. As here defined, and as illustrated and named in a former contribution to the Society †, there can be at least no doubt as to the answerable aspects and surfaces in any Invertebrate possessing comparable centres and cords of the nervous system, with comparable centres, or hearts, of the vascular system. So the heart in man indicates the "hæmal"

* *Antè*, p. 2.

† Journal of the Linnean Society (Zoology), January 1882, p. 131, figs. 2, 3, 7, 8.

aspect, the myelon the "neural" aspect of his body, as in the animals below him whether vertebrate or invertebrate.



Profile diagram of head and brain of insect, with fore part of the neural and hæmal tracts or centres, in the position thereby indicated.

The letters of reference are:—*a*. Hæmœsophageal centre or "ganglion" = fore brain. *b*. Neurœsophageal centre or "ganglion" = hind brain. *c*. Œsophagus traversing the crura cerebri, or connecting-cords, *d*, to the neurostome in its course. *e*. Nerve (olfactory?) to antenna. *f*. Optic nerve. *g*. Ocellar nerve. *h*. Mandibular nerve. *i*. Lingual nerve. *k*. Maxillary and labial palpal nerves. *l*. Stomach, or alimentary axis. *m*. Heart, or hæmal axis. *n*. Ganglionic cords, or neural axis = myelon. *o*. Foremost thoracic centre or "ganglion."

On Variations in Form and Hybridism in *Salmo fontinalis*. By Mr. Francis Day, F.L.S.

[Read November 2, 1882.]

There are few investigations more interesting in ichthyology than ascertaining the amount of variation which a given species of fish is capable of undergoing while adapting itself to new conditions of life; and there does not appear to be any form more susceptible of change, when introduced into new regions, than members of the genus *Salmo*. As opportunities occur of observing any modifications, I think it highly desirable that such should be recorded; for even if unimportant when taken alone, they may prove a link in some future inquiry.

During the past twenty years many additions to our knowledge of the natural history of members of this genus have resulted from carefully watching and noting the progeny of these fishes when introduced into the Antipodes by means of ova sent from this country.

It has seemed to me very desirable that we should likewise ascertain whether any changes occur in exotic forms acclimatized in Great Britain; and I have been especially anxious to watch the American brook-trout (really a charr), *Salmo fontinalis*. This fish is distinct from our common trout not merely in its colours, but also in the number of scales along its sides, having many more rows descending to the lateral line, while it possesses no teeth along the body of the vomer, but merely a patch or transverse band of from four to eight, situated opposite the conjunction of the palatine arch with the vomer.

For opportunities of making the following comparisons I have to thank Sir Pryse Pryse, of Goggerdan, Cardiganshire, Sir J. Gibson-Maitland, Bart., F.L.S., of Craigend near Stirling, and Mr. J. Carrington, F.L.S., of the Westminster Aquarium. For the American specimens I am indebted to Professor A. Agassiz.

I propose dividing the substance of my present paper under the following heads, each of which will require a short notice:—(1) The appearance of *Salmo fontinalis* as existing in its native country; (2) As living in this country in a wild condition in streams; (3) As kept in ponds into or through which there is a plentiful supply of running water; (4) As retained in aquaria where the water-supply is small; (5) Hybrid examples.

(1) The appearance of the American brook-trout has been so often described that recapitulation here appears to be unnecessary. I have found 57 vertebræ, and the anal rays from 2–3 / 7–8. The number of scales varies very considerably in the enumerations given by different authors, due to the two modes of counting in force. In one only the pierced row of scales along the lateral line is taken; and these vary from 115 to 140. But some ichthyologists assert that 200 or more rows exist along the lateral line; this is due to their counting the number of rows of scales passing down from the back and falling upon the lateral line. In a very well preserved male example in spirit in the British Museum from Lake Superior, $12\frac{1}{2}$ inches in length, the head is $4\frac{3}{4}$ in the total length, while the subopercle is nearly square, and the cæcal appendages are said to number 34.

(2) What are the appearances of this fish living in this country in a wild state in streams? It is difficult to answer this ques-

tion, because, owing to its roving disposition, the *Salmo fontinalis* is generally only for some period of its existence retained in ponds. I have been furnished with several fine examples from $9\frac{1}{2}$ up to $11\frac{1}{2}$ inches, and some smaller ones, by Sir Pryse Pryse from Cardiganshire; and they give the following results:—

B. x.–xi. D. 13 $(\frac{4}{9})$. P. 12–13. V. 8–9. A. 10–11 $(\frac{2\text{–}3}{7\text{–}8})$. C. 19. L. l. $\begin{array}{c}200\text{–}210\\ \hline 125\text{–}140\\ \hline 190\text{–}200\end{array}$. L. tr. $\frac{48\text{–}50}{58\text{–}62}$.

Length of head, males $4\frac{1}{2}$, females $4\frac{3}{4}$ to $4\frac{4}{5}$, of caudal fin 5 to $7\frac{1}{2}$ in the total length. *Eye*—diameter 5 to $5\frac{1}{2}$ in the length of the head, $1\frac{1}{2}$ diameter from the end of the snout and from its fellow. The maxilla reaches to beneath the hind edge of the eye. Subopercle differs, mostly nearly quadrangular; opercle generally much narrower in its upper than in its lower half. *Teeth* normal. *Fins*—all the smaller examples (that is, those most distantly removed from the United-States parent stock) have 2 to 3 undivided and 8 divided rays to the anal fin. My American specimen has 3 undivided and 7 to 8 divided rays in the same fin. At Howietoun all I have examined have 8 divided anal rays. If this is invariable, it demonstrates that the fish in this country develops the maximum number of its anal fin-rays as found in its native habitat. Cæcal appendages 25 in one examined. *Scales*—42 to 48 rows of scales from the lateral line to the base of the ventral fin; 21 to 26 rows in an oblique line from the posterior end of the base of the adipose dorsal fin downwards and forwards to the lateral line. *Colours*—the smaller ones with light sinuous lines, not seen in the large examples; covered with light round or oval yellow spots, which occasionally coalesce.

(3) What are the characters of this fish kept in this country in ponds wherein there is a plentiful supply of water? Personally I have only visited one such locality, the magnificent breeding-ponds at Howietoun, from which Sir J. Gibson-Maitland, Bart., has been so good as to furnish me with specimens. These fish, taken in July 1882, varied in length from $7\frac{1}{2}$ to $8\frac{1}{2}$ inches; and in every one the ova or milt was well advanced.

B. x.–xi. D. 13 $(\frac{4}{9})$. P. 12. V. 8–9. A. 11 $(\frac{3}{8})$. C. 19. L. l. $\begin{array}{c}185\text{–}206\\ \hline 122\text{–}125\\ \hline 188\text{–}200\end{array}$. L. tr. $\frac{36\text{–}47}{51\text{–}63}$. Cæc. pyl. 34.

Length of head, males $4\frac{3}{4}$ to $5\frac{1}{4}$, females $5\frac{2}{3}$, of caudal fin $6\frac{3}{4}$, height of body $4\frac{2}{3}$ to $5\frac{1}{2}$ in the total length. *Eye*—diameter $4\frac{1}{2}$ to 5 in the length of the head, 1 to $1\frac{1}{4}$ diameter from the end of the snout, and $1\frac{2}{3}$ to $1\frac{3}{4}$ apart. Maxilla reaches to beneath the hind edge of the eye. Posterior edge of preopercle regularly curved, and with a very short but distinct lower limb. As to the form of the opercle, it differs in the different examples: in one that on the right side of the head is not properly developed, leaving a portion of the gills exposed in a similar manner, though to a much less extent than observed in the trout and perch at Malham Tarn in Yorkshire, due, I am informed, to the occurrence of gill-fever in the early age of its existence. The subopercle also differs very considerably in the different specimens. *Teeth*—in none is there a median row of teeth along the body of the vomer, while the transverse band completing the palatine arch of teeth consists of from 3 to 5. *Fins*—the dorsal commences slightly nearer the snout than to the base of the caudal fin; the latter forked. *Scales*—40 to 49 rows of scales from the lateral line to the base of the ventral fin; 21 to 23 rows in an oblique line from the posterior end of the base of the adipose dorsal fin downwards and forwards to the lateral line. *Colours*—the light sinuous bands of the river-form are very slightly developed in these lacustrine fish, which are covered with oval or round yellowish spots, one or two of which occasionally run into one another, while red spots exist on, above, and below the lateral line.

The eggs from which these fish were reared were received direct from the Cold-Spring trout-ponds, New Hampshire, U. S.

The external appearance of these charr is different in colour from small ones received from Welsh rivers, but more similar to the larger examples. Whether such is accidental or will be persistent so long as the same influences are at work, only time can decide.

(4) The appearance of these fish as detained in aquaria where the water-supply is insufficient. By this I do not mean insufficient for life and health, but for continuation of the species. The example I possess was given me by Mr. J. Carrington; it is 9 inches in length, in good condition, and, when received, had brilliant colours. It was reared by the late Mr. Frank Buckland in his tanks at the Horticultural Gardens at South Kensington from eggs received direct from Lake Huron. He presented some young to the authorities of the Westminster Aquarium soon after it was opened; and the fish on the table is the last which survived, having died in October 1879 from jumping out of its tank.

B. x.–xi. D. 13 $(\frac{4}{9})$. P. 11. V. 8. A. 10 $(\frac{3}{7})$. L. l. 130. L. tr. 49/64.

Length of head $4\frac{1}{4}$, height of body $5\frac{1}{3}$ in the total length. *Eye*—diameter 6 in the length of the head, $1\frac{2}{3}$ diameter from the end of the snout, and 2 diameters apart. Subopercle twice as long as deep. *Teeth* normal. *Scales*—43 rows between the lateral line and the base of the ventral fin; 24 rows from the hind edge of the base of the adipose dorsal downwards and forwards to the lateral line.

Before passing on to the next specimen from Cardiganshire, I would allude, for comparison, to some examples of brook-trout received from the same locality and from the same donor.

B. xii. D. 12–15 $(\frac{3\text{–}4}{9\text{–}11})$. P. 13–15. V. 9. A. 10–12 $(\frac{3}{7\text{–}9})$. C. 19. L. l. $\frac{128\text{–}135}{\frac{113\text{–}115}{118\text{–}125}}$.

Scales—13 rows from the posterior edge of the base of the adipose dorsal fin downwards and forwards to the lateral line; 26 rows from the lateral line to the base of the ventral fin.

(5) *Hybrids.*—Some excellent anglers have informed me that *Salmo fontinalis* has interbred in the Wandle, and also in Cardiganshire waters, with the common brook-trout. I have also been told that the same occurrence has taken place elsewhere. Hunter, we know, was of opinion that hybrids were not productive except in cases where the generative organs were in a state of perfection, a state which might be considered unnatural in hybrids. These views have been considerably modified of late years; and the opinion of Pallas seems regarded as reasonable, that domestication tends to eliminate hybridism. Be this as it may, we know from the experiments of Rasch and others that hybridism between the charr and the trout, and the salmon and the trout, may be brought about, and it has been stated that occasionally their offspring are prolific*.

I have had examples sent to me which certainly appeared (judging solely by external form and colour) that such an admixture had resulted. A minute examination, however, failed to confirm first impressions, the small size of the scales of the American trout and its peculiar dentition showing that no reliance could be placed on

* Mr. Davidson informs me of a hybrid having existed in the East between a Muscovy and a Common Duck. One female laid many eggs of a deep sea-green colour; but every trial to hatch such proved abortive. Consequently I think it may not be unreasonable to argue that the existence of ova or milt in fish may not be absolute proof of sterility or prolificness. Here the fish-culturist's opportunities for observation will doubtless prove invaluable.

the external form and colour. At last, in June this year I received from Sir Pryse Pryse an undoubted hybrid; its total length was 9 inches. The fish is now on the table.

B. x. D. 14 $(\frac{4}{10})$. P. 14. V. (right) 9, (left) 8. A. 11 $(\frac{3}{8})$. C. 19. L. l. $\frac{170}{\frac{119}{160}}$. L. tr. 27/39.

Length of head 5, of caudal fin $5\frac{1}{3}$, height of body 5 in the total length. *Eye*—diameter one fifth of the length of the head, $1\frac{1}{4}$ diameter from the end of the snout and $1\frac{3}{4}$ apart. Posterior edge of the preopercle somewhat angular at its centre, and again where it commences to form its lower limb, which is distinct. Width of opercle equal to two thirds of its height. Height of subopercle at its base $2\frac{1}{4}$ in that of the opercle, and having a rounded posterior edge. *Teeth*—2 at the anterior portion of the body of the vomer where it joins the palatine arch; 6 more along the body of the bone, the anterior 4 in alternate rows, the last 2 single and the most posterior one the largest. *Fins*—dorsal commences midway between the end of the snout and the base of the caudal, which latter fin is forked. *Scales*—119 rows along the lateral line; 29 from the lateral line to the base of the ventral fin; 19 rows in an oblique line from the posterior end of the base of the adipose dorsal downwards and forwards to the lateral line. Fish sterile: this of course may be temporary; but examples of a similar and even smaller size from Howietoun had the ova and milt well developed. *Colours*—those of fluviatile *Salmo fontinalis*, being grey rivulated with broad serpentine bands of yellowish white, or forming rings enclosing grey blotches which have a light centre. A few red spots along the lateral line, but none apparent above or below it. Dorsal, caudal, and ventral fins coloured similarly to *S. fontinalis*; but the black band to the anal at the base of the white outer edge not so distinct.

Here, as shown by the scaling and dentition, was an undoubted hybrid between the American charr and the common brook-trout; but it was sterile. It would be exceedingly interesting were a close scrutiny to be kept on any of these fish captured in a wild state, in order to ascertain when hybrids are present, and also to be clear as to whether such are sterile or the reverse. Until more examples have been obtained, I do not propose offering any opinion upon the foregoing interesting specimens, but merely to record facts. Sir J. Gibson-Maitland possesses numerous year-ling hybrids, the progeny of a male *Salmo salar* and a female Loch-leven trout. The interesting and practical question arises, Will these, as a rule, be sterile or prolific? If sterile, will they possess the migratory instinct of the salmon or the non-migratory habits of the brook-trout. Should the latter occur, rivers, such as the Thames, might be stocked with fish suitable for sport and food above the polluted portion. Then, again, would arise the inquiry whether they would remain in condition all the year round; for if so, such stock might afford constant sport to the angler, while the captures would be clean fish.

Notes on some little-known Collembola, and on the British Species of the Genus *Tomocerus*. By George Brook, F.L.S.

[Read December 7, 1882.]

(Plate I.)

The four species which form the subject of the present notes have all been described by Tullberg. Dr. Reuter has come across a single specimen of *Tomocerus vulgaris* in Shetland, and also a single specimen, which he queries *Achorutes manubrialis*, from Finland. With these two exceptions I am not aware that any of them have been since observed. Tullberg's specimens were from Sweden, so that notes of their occurrence in England and in Jersey may prove of value. When quoting Tullberg I have made use of his latest descriptions, as these are in some cases altered a little from the originals.

Achorutes manubrialis, Tullb. (Pl. I. figs. 1–5.)

In October 1880, while on a dredging-trip with Dr. Murie, we landed one day on Warden Point, Thanet, and began searching the sun-dried blocks of clay on the beach. Amongst the crevices of one large block I found swarms of an *Achorutes*, which appeared at first sight to be *A. purpurescens*, Lubbock; but a closer inspection made this doubtful, and we collected a good many for reference. Twelve months passed over without the specimens being examined; but when at last they were brought out, they proved to be *A. manubrialis*, Tullb., and an addition to our fauna.

Tullberg's description is as follows:—"Unguiculus inferior adest. Dentes furculæ, manubrio breviores, vix duplo longiores quam mucrones, qui graciles sunt. Spinæ anales perparvæ.

Long. 1 mm.;"* and I may add from his original description, "Ocelli in macula nigra positi, unguiculus superior sine dente, inferior parvus" †.

In this species the anal spines are not so large as in *A. purpurescens*, and the papillæ on which they are placed are very small and further apart than in Lubbock's species. The chief distinction, however, lies in the spring. In *purpurescens* the *manubrium* is not longer than the *dentes*, and the latter gradually taper off into the *mucrones* with merely a faint line to show the point of union. In *manubrialis*, on the contrary, the *manubrium* is as long as the *dentes* and *mucrones* together. The *dentes* do not taper as in *purpurescens*, but end abruptly in the *mucrones*, which are slender and convergent. The latter character is useful in helping to distinguish from *A. Theelii*, Tullb., an intermediate species, which has the mucrones not convergent and the dentes tapering a little more than in *manubrialis*, but still with the point of union between the dentes and mucrones quite distinct. It may be doubted whether, in making such minute differences of specific value, Tullberg is not going a little too far; but it would be impossible to judge fairly without comparing a large number of specimens. In any case *manubrialis* appears to be sufficiently distinct from *purpurescens* to rank as a separate species. Its body-colour is similar to that of *purpurescens*, namely a dark blue-grey. My specimens, however, which have now been two years in spirit, show lighter patches dotted over the body, but not sufficiently large to alter the general colour to the naked eye. In other respects they agree with Tullberg's description.

XENYLLA MARITIMA, Tullb. (Pl. I. figs. 6–10.)

The genus *Xenylla* contains at present four species, none of which, as far as I am aware, have yet been found in England. Tullberg distinguishes it from *Achorutes* as follows:—"Ocelli 10; 5 in utroque latere capitis. Organa postantennalia desunt. Furcula parva, non ad tubum ventralem pertinens spinæ anales 2" ‡. The real distinctions of *Xenylla* are as follows:—The spring, which is short (extremely so in *X. brevicauda* and *X. nitida*), is of a peculiar construction. The manubrium is almost triangular in shape; and the dentes taper so suddenly into the

* Sveriges Podurider, 1872.

† Skan. Podur. af Underfam. Lipurinæ, 1869.

‡ Sveriges Podurider, 1872, p. 52.

mucrones that it is almost impossible to say where the exact point of union is. In *Achorutes*, on the contrary, the contour of each segment of the spring is well marked; for even in *A. purpurescens*, Lubbock, although the dentes gradually taper into the mucrones, there is a distinct line across marking the point of union. In *Xenylla* there is no lower claw, and the number of ocelli on each side is five instead of eight as in *Achorutes*. There are always two tenent hairs on each tibia; I have seen three in one or two instances.

X. maritima, Tullb., is distinguished as follows:—"Undique prunosa. Dentes furculæ cum mucronibus longitudinem tibiæ æquantes. Spinæ anales parvæ, papillis latis affixæ. Long. 1½ mm." *

This species is distinguished from the others of the genus by its larger spring, with more suddenly tapering dentes, and by the position of the extremely small anal spines, which are placed on two broad papillæ *touching at the base*; while in *X. brevicauda* and *X. nitida* the anal spines are placed on papillæ only slightly larger than the granulations of the skin and with their bases comparatively wide apart. My specimens were sent to me by Mr. J. Sinel of Jersey, who collected them in Dec. 1881 under damp wood, curiously enough in the company of *Tomocerus vulgaris*, Tullb., about which I shall have something to say later.

TRIÆNA MIRABILIS, Tullb. (Pl. I. figs. 11–14.)

Tullberg's diagnosis of this genus is as follows:—"Organa postantennalia nulla; ocelli 16, 8 in utroque latere capitis. Antennæ conicæ, articulo quarto gracillimo. Unguiculus inferior nullus. Furcula perparva, dentibus papilliformibus. Spinæ anales 3"†.

This genus, which contains as yet only one species, is nearest related to *Anurida* of Laboulbène, which it resembles greatly in the mouth-parts. These present a transitional stage between *Lipura*, in which the mandibles have a certain limited freedom of action, and *Anoura*, in which the mouth is entirely suctorial. Besides the three anal spines and the absence of a postantennal organ, the chief characteristic of *Triæna* lies in the formation of the spring. This is the most rudimentary one yet described, and merely consists of a small basal piece and of two almost

* Sveriges Podurider, 1872.

† Ibid.

wart-like dentes, each with an extremely small and indistinct mucro.

Triæna mirabilis is a small blue-grey insect about $1\frac{1}{2}$ millim. long, with distinct eye-patches as in *Achorutes*. The three anal spines are rather large for the size of the insect, and broader towards the base. Besides the spines the fifth abdominal segment is usually provided with strong hairs which, unless accurately focused, look broad enough at the base to be taken for spines.

Tullberg found his specimens under boards in a farmyard and also amongst seaweed cast up on the shore. My specimens, five in number, were also found under boards in my garden. One appears to have had five anal spines. There are the usual three on the sixth abdominal segment; and some considerable distance higher up, above the middle of the fifth abdominal segment, is a fourth spine similar in all respects to the others; but the corresponding one on the other side appears to have been broken off. The specimen appears to agree with *T. mirabilis* in other respects, so that perhaps this is only an accidental variation.

TOMOCERUS VULGARIS, Tullb. Fört. Œfver., Sv. Podur. 1871. (Pl. I. figs. 15–19.)

Tullberg's diagnosis of this species is as follows:—"Antennæ corpore non longiores. Spinæ dentium simplices 12–16, intima magna. Unguiculus superior dentibus 4–6 armatus; inferior muticus, lanceolatus. Long. 4 mm." Tullberg gives the ground-colour as grey, and the locality under bits of wood, bricks, &c. near houses. My specimens agree almost exactly with the above description, but the body-colour is rather dirty yellow than grey. But here, as has been usual with the specimens I have examined of other species, the body-colour was sometimes tinted with a reddish brown. Of course I speak of specimens in spirit; what the body-colour may have been when the insect was alive I cannot say. This species is easily distinguished from *T. tridentiferus* by the simple spines on the spring and by the lanceolate lower claw. The spines are arranged with a slight curve at the end nearest the manubrium, very much as in *T. tridentiferus*. In this genus, and particularly in this species, the claws are large and show well both the pseudonychia and the double lamelliform nature of the upper claw. As will be seen from the figure, the upper claw consists of two thin plates cemented together along the outer margin, but at such an angle as to leave a considerable distance between the inner margins. Seen from above, the claw shows several transverse bars, which are very distinct in some specimens. I cannot say what these are, but they may be thickenings between the two plates of the claw. Dr. O. M. Reuter, in his study on the function of the ventral tube ('Etudes sur les Collemboles,' Helsingfors, 1880), has some very interesting remarks which show the utility of this hollow upper claw. Speaking of *Smynthurus apicalis*, Reuter, he records having many times watched this little insect rub one of the antennæ with one or other of its claws, holding it so that the hollow was touching the antenna. By this rubbing motion a tiny drop of water was gradually collected from the hygroscopic hairs and pushed nearer and nearer to the tip of the antenna, until at last it was received into the hollow of the claw and transferred towards the mouth. At the same time the ventral tube was pushed forwards and the drop divided between the two tubes and the mouth. It is probable that in any of the long-bodied Collembola the ventral tube would not reach as far as the mouth; but still the claw might be used as described by Reuter for *Smynthurus*.

My specimens were gathered under damp wood in Jersey in Dec. 1881, and sent to me by Mr. J. Sinel.

On the British Species of the Genus TOMOCERUS.

Lubbock, in his Ray Soc. monograph, describes three British species of *Tomocerus*, viz. *T. longicornis*, Müller, *T. plumbea*, L., and *T. niger*, Bour. Of these the first named is regarded by Tullberg as the *T. plumbea* of Linnæus, because Lubbock's *T. plumbea* has not been found in Sweden, whereas the form with long coiled antennæ is very common there, and is found in just such localities as described by Linnæus in his 'Fauna Suecica.' Thus it would appear best for us to drop the specific name *longicornis*, and adopt that of *plumbea*, L., for this species. Next, as regards the *T. plumbea* of Lubbock and *T. niger*, Bour. The only real difference between these two species appears to be that *T. plumbea* has the body-colour grey when devoid of scales, while in *T. niger* it is yellow. It is very questionable whether in any case the body-colour of a scaled species of Collembola is of sufficient importance to be taken as a specific character. Of the many specimens I have examined, referable to one or other of these species, the majority have had yellow as the basis of the ground-colour, sometimes with brown patches and sometimes with the yellow fading away into a leaden colour almost like that of the scales. Thus, as the colour is so variable, it appears impossible to make it of specific value here at any rate, and the two species should be united. In fact, if naturalists describing these insects would pay more attention to even minute morphological details and not spend so much time in recording the position of every little patch of colour, we should not be troubled with so many synonyms.

It appears that the common English species of *Tomocerus* is identical with the *T. tridentiferus* of Tullberg; in fact in the north of England at least it is very much more plentiful than *T. plumbea*, L., of Tullb.; while in Sweden the reverse is the case, Tullberg himself not having seen *tridentiferus* alive when he described the species. It is very easy to distinguish, as it is the only species yet described with tridentate spines on the spring. Lubbock indeed does not distinctly say that the spines in his species are tridentate; but he remarks that they "have small processes at the sides," which amounts pretty much to the same thing. Of the specimens I have examined there are a few with the lateral teeth so small that Lubbock's description would appear more applicable, but the great majority have the spines distinctly tridentate. I am not aware of any other observer having previously noted this tridentate species; and as Lubbock's name is now taken up, it appears that that of Tullberg should stand. Since the publication of Sir John Lubbock's monograph Tullberg has described several new species of *Tomocerus*, in the diagnosis of which great stress is laid on the number and arrangement of the caudal spines. As in the descriptions of our British species this has not specially been noted, perhaps it would be as well to add here a short diagnosis of each species.

Tomocerus plumbea, L., of Tullberg, Sveriges Podurider, 1872, =*T. longicornis*, Müller, &c.

Antennæ much longer than the body, the 3rd and 4th segments often coiled up. Spines on the dentes simple, 7–8 on each side, small, and arranged in almost a straight line. Upper claw with two or three teeth; lower one acuminate, produced into a hair-like point and with a minute tooth.

Tomocerus tridentiferus, Tullb. Sveriges Podurider, 1872.

Antennæ not longer than the body. Spines on the dentes tridentate, 10–11 on each side, 3 or 4 nearest the manubrium, the last and either the last but two or the last but three considerably larger than the others; the 4 or 5 nearest the manubrium arranged in a curve, the others nearly in a straight line. Upper claw with 5 or 6 teeth, lower one broad and suddenly tapering from a small tooth on the inner margin.

Tomocerus vulgaris, Tullb. Fört. Œfver., Sv. Pod. 1871.

A description of this species has already been given, so that it is needless here to repeat it. Dr. O. M. Reuter obtained a single specimen of this species in Shetland in the summer of 1876 (see 'Scottish Naturalist,' Jan. 1880).

I am not aware that this species has since been recorded as British.

DESCRIPTION OF PLATE I.

All the figures are given on an enlarged scale.

Fig. 1. Dorsal view of *Achorutes manubrialis*, Tullb. From a photograph.
2. Ventral view of the same.
3. The spring of ditto.
4. Claw of ditto.
5. Anal spine of ditto.
6. Dorsal view of *Xenylla maritima*, Tullb.
7. Ventral view of the same.
8. Anal spines of ditto.
9. The claw of ditto.
10. Eye-patch of ditto.
11. Dorsal view of *Triæna mirabilis*, Tullb. } After Tullberg.
12. The spring of ditto.
13. The claw of ditto.
14. Abdominal segment showing spines, and at *a* the abnormal one.
15. Dorsal view of *Tomocerus vulgaris*, Tull. } After Tullberg.
16. The spring of the same.
17. The mucro of ditto.
18. A side view of the claw.
19. The claw from above.

Note on the Type Specimen of *Carpophaga Finschii*, Ramsay. By E. P. Ramsay, F.L.S., C.M.Z.S., &c., Curator of the Australian Museum, Sydney.

[Read November 16, 1882.]

In a former paper, which this Society did me the honour to publish in their Journal (Zool. xvi. p. 129), I gave a description of this fine species, but unfortunately at that time was not in a position to give the measurements, which want I am now enabled to supply, the type, still unique, having been kindly presented to me by the Rev. George Brown. I find also that the locality from which it came is "Irish Cove," on the island of New Ireland.

Measurements of the type specimen of Carpophaga Finschii:—Total length of skin 12 inches, wing 8·2, tail 4·8, tarsus 1, mid toe (s. u.) 1·2, hind toe (s. u.) 0·65; bill from forehead 1·15, from the nostril 0·6, from the gape 1·2.

Remarks.—Several of the outer tail-feathers and the centre two are scarcely half-grown; but from what can be seen of them, they appear to be of the same colours as exhibited in the remainder; the under wing-coverts are ashy, with bluish-ashy margins, of the same tint as that of the back of the neck. The total length of the bird, when alive, was about 14·5 inches.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part XVI.

By the Rev. ROBERT BOOG WATSON, B.A., F.R.S.E., F.L.S.

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[Read November 16, 1882.]

Fam. FISSURELLIDÆ, *Risso.*

ZEIDORA, *A. Ad.* | PUNCTURELLA, *R. T. Lowe.*

Zeidora is classed here under the Fissurellidæ in accordance with the view of its author, from which, in the absence of the animal, it would be rash to depart. It seems, however, rather an internal than an external shell; and its true place will probably be found among the Opisthobranchia, perhaps in the neighbourhood of *Pleurobranchus*. *Crepiemarginula*, a genus proposed by Prof. Seguenza for a Pliocene fossil of great rarity, is A. Adams's *Zeidora*.

In reference to the Puncturellas, the species hitherto known are very few. Adams in the 'Genera' (vol. I. p. 451) enumerates only seven; and of these, *P. princeps*, Mighels and Adams, and *P. galeata*, Gould, are certainly the same as *P. Noachina*, L.; while others probably need revision. Dr. Gwyn Jeffreys, in his 'Valorous' Report (Ann. & Mag. N. H. Mar. 1877, p. 232) describes one new species, and refers to three others from the 'Porcupine' dredgings, of which two are Sicilian Pliocene fossils described by Seguenza. Mr. W. H. Dall, in his "Report on the Blake Dredgings" (Bull. Mus. Comp. Zool. Harvard Coll., Camb., Mass., Aug. 25, 1881, pp. 75, 76), has described two new and very interesting species from the Gulf of Mexico. One of the species from the

'Challenger,' *P. craticia*, Wats., seems the largest yet described. Some of the others, though small, are remarkable for form or sculpture, or both; all, unfortunately, are represented by but a few specimens. In addition to the Stations referred to below, only three others afforded specimens of *Puncturella* to the 'Challenger'; these are:—St. 312, in the Straits of Magellan; St. 145, between the Cape and Kerguelen; and St. 149, at Kerguelen: and at all these places the species obtained was our British *P. Noachina*, L.

Looking at these facts, one is struck by the very large number (no fewer than eight) of new species from one locality. Further, if we take in connection with this the poverty of specimens from that locality, and also the rarity of the genus in the dredgings in general, we can hardly doubt that the true home of the genus has not yet been found.

Gen. Zeidora, *A. Ad.*

Zeidora naufraga*, n. sp.

St. 24. Mar. 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, North of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—White, delicate, depressed, oblong, pointed behind, with a minute short apex, rounded and cleft in front, with a broad flat keel bearing the old cleft-scar and extending the whole length of the shell: the enormous mouth is closed behind by a crepidula-like partition. *Sculpture.* Longitudinals—from the apex to the cleft across the middle of the back runs a broad raised keel, flat on the top, where it is scored by the minute delicate, sharp, prominent, close-set, but not contiguous scars of the old cleft; on either side it is bordered by a sharp marginal line: from these marginal lines branch off feeble irregular diverging threadlets, between which, as they go wider apart, others arise; the intervals between them are two to three times the breadth of the threadlets. Spirals—strictly speaking there are none, but the whole surface is scored at right angles to the longitudinals with a series of threadlets, very similar in form but rather more closely set; these radiate from the apex and indicate the old mouth-edges. *Colour* porcellaneous white, which is dead on

* The name was suggested by the resemblance of the shell to a half-decked boat which has been shipwrecked.

the threadlets, but almost translucent elsewhere from the extreme thinness of the shell. *Apex*—at the posterior end of the shell there is a narrow, rounded, prominent beak, within which, a little bent to the right and projecting slightly above the margin of the mouth, is the minute apex of one whorl. *Mouth* oblong. *Margin* minutely denticulated by the ends of the ribs; cleft in front by a strong, parallel-sided, blunt-ended fissure; behind, it is peculiarly patulous, being markedly bent outwards from the line of attachment of the septum, this bending being strongly shown on the outside of the shell. *Inside* glossy, smooth; a strong depression corresponding to the exterior keel extends from end to end of the shell. *Septum*—a little way within the margin, and deepest at the end, is the short oblique septum, which is faintly arched, with a concave edge in front. L. 0·38. B. 0·2. H. 0·12.

The present species, though somewhat chipped, is of great beauty. It differs from *Z. calceolina*, A. Ad., which is rudely cancellated, and is also wider and more depressed. It is liker *L. reticulata*, A. Ad.; but is larger, deeper, has the old cleft-scar raised on a projecting ridge which forms a strong internal furrow, has the beak sharper and more projecting; the form is more oblong and more pinched-in at the sides; the sculpture-lines are much finer and less regular than in that species.

[Since the above was in print, Prof. Seguenza has had the kindness to send me a careful sketch of the solitary specimen which exists of his *Crepiemarginula reticulata* from the Astian or Middle Pliocene of Rhegium in Calabria (see 'Formazione Terz. de Reggio-Calabria,' p. 273). It proves, as I inferred from the description, to be a *Zeidora*; and as in that genus *reticulata* is a specific name already used by A. Adams, I would propose *Z. Seguenzæ* for the Calabrian fossil. As compared with *Z. naufraga*, this Calabrian fossil is much higher in front, much lower behind, where also it is much broader and rounder, with a less pinched-in apex; it is more widely ribbed, the scores on the scar are wider apart and coarser; internally the edge is more coarsely crimped, and the septum is very much larger, being much more prolonged forward, and is horizontal instead of oblique; the old cleft-scar, too, is not raised on a projecting ridge, and does not form any internal furrow.]

Gen. Puncturella, *R. T. Lowe.*

[Since the publication of this group I have had the opportunity, through the kindness of Dr. Gwyn Jeffreys and of Prof. Seguenza, of examining some species described by them or in their hands; and I am satisfied that *P. craticia*, Wats., is *Rimula asturiana*, Fischer, of the 'Travailleur' Expedition, 1880; that *P. tuberculata*, Wats., is *Rimula granulata*, Seg., an Upper-Miocene fossil; that *P. plecta*, Wats., is *P. clathrata*, Jeffr., of which, however, as an unpublished species mine must, to my regret (for the species has long been differentiated by Dr. Gwyn Jeffreys), take precedence; that *P. acuta*, Wats., is the *P. profundi*, Jeffr., not, however, a *Fissurisepta*, Seg., for it retains its apex, nor indeed a simple *Puncturella*, for its delicate septum is a broad straight lamina extending direct from side to side of the shell, and advancing obliquely a considerable way down the interior of the shell (see 'Valorous' Gastropoda, Ann. & Mag. N. H. Mar. 1877, p. 232); and that *P. acuminata*, Wats., is one of the varieties of *Fissurisepta rostrata*, Seg., an Upper-Miocene fossil. The identification of these West-Indian mollusks with Miocene fossils and with a species living in the Bay of Biscay (600 to 1100 fms.) is obviously of much greater interest and importance than the mere multiplication of new species.]

1. *P.* (*Cranopsis*) *asturiana*, Fischer.
2. *P.* (*C.*) *granulata*, Seg.
3. *P. agger*, n. sp.
4. *P. brychia*, n. sp.
5. *P.* n. sp. (?)
6. *P. plecta*, n. sp.
7. *P. profundi*, Jeffr.
8. *P. oxia*, n. sp.
9. *P. sportella*, n. sp.
10. *P.* (*Fissurisepta*) *rostrata*, Seg.

1. Puncturella (Cranopsis) asturiana, *Fischer* [craticia, n. sp.].

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Fischer, 'Journal de Conchyliologie,' 1882, p. 51 (*Rimula*).

Shell.—Grey, thin, depressed, oval, considerably broader in front than behind; with straight conical sides, convex in front and concave behind, where in particular the margin is a little patulous: it is scored with sharpish ribs and concentric threads; the lanceolate slit is large and very low placed. *Sculpture.* From the point 30 to 40 sharpish ribs radiate out, in whose interstices as they diverge smaller ones appear, which finally rival the first, so that toward the margin 100 to 130 can be counted. The one in continuation of the generic puncture is slightly raised, double, and partially split, especially above, giving the impression of a suture; these are crossed by concentric threads of almost equal strength with the ribs, in crossing which they rise into knots which sharply roughen the surface. *Colour* brownish grey, but the specimen is somewhat blackened and discoloured *. *Apex* a good deal depressed, curled-in and projected backwards exactly in the middle line of the shell, the minute tip just standing out on the right, forming a spire of $2\frac{1}{4}$ whorls. *Slit* very low, having its centre quite two thirds down the front slope; it is lanceolate, square behind, broadening, a little irregularly, in the middle, and slowly contracting to a small narrow point in front: the old scar is a shallow furrow with sharp sides; and the bottom is scored across with old edge-lines. *Margin* thin, toothed, and crimped on the edges by the ribs. *Inside* porcellaneous, somewhat indented on the line of the ribs; the apex is deeply hollowed, a deepening and widening groove extends from the margin to the slit, which is shortly covered by the regularly curved, strong, unbuttressed septum. L. 0·8. B. 0·62. H. 0·32.

My own observations entirely confirm the remarks of Mr. W. H. Dall ('Blake' Dredgings, Bull. Mus. Comp. Zool. Harvard Coll. vol. IX. p. 76), that the presence or absence of buttresses to the septum is a feature that cannot be taken as a basis of distinction, since it is not constant in the same species.

In descriptions of species under this genus a good deal of confusion would be avoided if it were remembered that the fissure lies in front of, not behind, the apex. The whole of Gould's descriptions of *Rimula* (U.S. Expl. Exped., Moll. pp. 368–372, figs. 475–478) apply to this genus—a fact one would hardly recognize from his figures of the animals, in which the tentacles are represented of extreme length and fineness.

The 'Challenger' species is exceptionally large. In outline it somewhat resembles *Rimula cognata*, Gould. My remembrance of this species is that it is quite small; but Gould figures it large, and gives no indication of size beyond saying that it is small. *Puncturella craticia* further differs from it in being much rounder and lower, with a more depressed and reverted apex, and a slit much more remote from the top.

* The colour of living specimens from the Bay of Biscay proves to be very much the same.

2. PUNCTURELLA (CRANOPSIS) GRANULATA, *Seg.* [TUBERCULATA, n. sp.]

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Seguenza, 'Palæont. Malac. Terr. Terz. di Messina,' p. 14, pl. v. f. 6 (*Rimula*).

Shell.—Porcellaneous white under a meagre yellow epidermis, rather thin, narrow, broader in front, oblong, with a depressed and reverted top and incurved apex; the side slopes are steep and slightly convex, the front edge is long and very convex, the back slope is concave in consequence of the overhanging apex; the small close-set radiating ribs are beaded with contiguous small rough tubercles; the long narrow fusiform slit rises very high, and is remote from both apex and margin. *Sculpture.* From the apex over 100 small irregular and unequal riblets radiate to the margin; they are closely beset with small rough tubercles like threads; there are no concentric threads, but a few unequal lines of growth can be seen; the riblet which runs from the slit is double, with a minute furrow between the riblets; its direction is not quite constant in different specimens. *Colour*: the shell is pure white, porcellaneous under the thin straw-yellow membranaceous epidermis, which is rather caducous. *Apex* very much reverted and depressed so as to stick out backwards bluntly, but prominently in the mid line of the shell; the minute smooth white tip stands out on the right with considerable distinctness, completing a regular spire of 2½ whorls in all. *Slit* stands very high, its upper end rising to the crest of the shell, though still remote from the apex; it is long, narrow, and deep, and tapers off at both ends; the old scar is deep and narrow. *Margin* thin and sharp, toothed all round, but hardly crimped within; behind it is very patulous, but elsewhere the internal slope is very steep; the two sides are very straight and converge backwards. *Inside* porcellaneous, deeply hollowed into the apex; a sharp little furrow that resembles a crack runs up from the margin to the slit, which is almost quite covered in all its length by the patulous but small and flatly arched unbuttressed septum. L. 0·31. B. 0·19. H. 0·15.

This species is peculiarly long and narrow, and roomy within from its steep walls and blunt apex. Its sculpture, too, is very striking.

3. Puncturella agger*, n. sp.

St. 24. March 25, 1863. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Small, porcellaneous, oval, broader in front; side slopes straight, the front convex, the back concave, rather high, but with the top depressed and thrust out backwards, yet little projecting, the apex being flattened out on the posterior slope; there are many not crowded slight radiating ribs set with stumpy prickles; the long and lanceolate slit is on the crest, and from it a ridge runs down the front slope. *Sculpture.* The riblets are very slight, but are made distinct by the little triangular prickles which pretty closely stud them; these prickles more irregularly and remotely tally with feeble lines of growth; the ridge down the front slope is small, and is crowned with two of the riblets parted by a narrow furrow; these riblets along the slit rise into sharp laminæ. *Colour*: the shell is porcellaneous white, with a slight ruddy tinge. *Apex* somewhat depressed and shortly projected backward, curling in on the central line of the shell, but with the extreme tip flattened-out on the posterior right slope; there are $2\frac{1}{4}$ whorls in all. *Slit* lies high on the front slope, distant from the apex about once and from the margin about twice its own length; it is long and narrow, bluntly rounded at the upper end, and produced in front to a long sharp point. *Margin* is thin and not fretted with the rib-ends. *Inside* glassy, deeply hollowed into the apex, feebly rayed, and having the rays picked out with bright specks corresponding to the extenal prickles: a long shallow furrow, bordered by a minute ridge on either side, runs widening upwards from the margin to the slit, which is covered in all its length by the somewhat contracted, sinuous-edged, cross-scored, straight, glassy septum, which arches in to the apex. L. 0·17. B. 0·13. H. 0·09.

This species has somewhat the form of *P. tuberculata*, but is not so compressed, and the sculpture is quite different.

4. Puncturella brychia, n. sp. (*βρύχιος*, deep sea.)

St. 47. May 7, 1873. Lat. 41° 15′ N., long. 65° 45′ W. Off Halifax, Nova Scotia. 1340 fms. Mud.

Shell.—Very small, porcellaneous, translucent, oval, very

* So called from the little ridge that runs down from the front slope of the shell from the slit.

slightly broader in front; its side slopes are slightly, its front slope extremely convex, its back slope is short and flattened and very much overhung by the protuberant apex; there are sparse and distinct riblets. The slit is short and coarse, though not large; and from it a broad round ridge trending to the right runs out to the margin. *Sculpture.* The riblets are neither strong nor sharp; but they are distinct, rising as little round threads from the flat surface, and being parted by broad intervals, rather strongly pitted by the little specks of the genus; the ridge which runs down the front of the shell is the full breadth of the slit; the concentric striæ are mere slight irregular lines of growth. *Colour* clouded, porcellaneous white under the brownish caducous epidermis. *Apex* very much curled in and bent down, but not spread out on the backward slope; the minute extreme tip is exserted and projects; the whorls are $2\frac{1}{4}$. *Slit*: the open part is short and narrowly oblong, and as broad in front as behind, from which point the old scar runs up the crest. *Margin* thin, patulous, especially behind, crenulated by the riblets. *Inside* porcellaneous, deeply hollowed into the apex; scored by the rib-furrows, of which the one in front is very strong, particularly near the slit, which is rather closely covered by the strong, slightly arched septum, which has a retracted edge and is unbuttressed. L. 0·18. B. 0·12. H. 0·1.

In the animal the eye-peduncles are present; but no eyes are visible; the pedal papillæ are very small, as is also the funnel-shaped process leading to the shell-slit.

This species in general form is a good deal like *P. agger*, but is more tumid and higher; the apex and sculpture are very dissimilar. Than *P. conica*, d'Orb. (*Rimula*), which is much of the same size, *P. brychia* has the apex much more turned over; the form is broader and much more depressed.

5. Puncturella n. sp. (?)

Sept. 7, 1874. Torres Straits. North of Australia. 3–11 fms.

Sept. 8, 1874. Torres Straits. Flinders Passage, North of Australia. 7 fms.

St. 186. Sept. 8, 1874. Torres Straits. Wednesday Island, North of Australia. 8 fms.

St. 187. Sept. 8, 1874. Torres Straits, Cape York, North of Australia. 6 fms.

This species, which I believe to be new, is peculiar from its high, perpendicular, roundly oval form, ending in a minute reverted, hardly in-curled, prominent tip which overhangs the base; the longitudinal striation consists rather of corrugations than ribs; and the lines of growth are slight and unequal. The slit, which is small and oval, arises simply from the removal of the crest. The inside is corrugated like the outside, the opening runs up and backwards into the apex; the septum, which is flatly arched, lies very close to the front wall of the shell and comes far down.

I have not described the species, because none of the specimens are in very good condition. They are also all very small; but the species is probably a small one, judging from the minute size of the embryonic shell. Coming from a locality visited and carefully dredged by the 'Chevert' Expedition, the species might be expected in the lists of that expedition given in the N. S. Wales Linn. Soc. Proc. 1876–78. I have failed to find it there; but some other explorer of that difficult record may be more successful.

6. Puncturella plecta, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Small, porcellaneous, oblong, scarcely perceptibly broader in front; its slopes are conical and straight till close to the top, which projects backwards but little; there are strongish ribs and still stronger concentric threads; the slit is short and broad. *Sculpture.* There are about 35 strongish rounded riblets with feebler ones between, bringing up the total number to 60 or 70; overlying these, and forming minute knots at the crossings, are rather stronger, concentric, rounded threads, giving to the surface the wattled appearance from which the name is taken. *Colour* faintly brownish grey. *Apex* rather coarse, curled in, but very little reverted or flattened; there are just two whorls in all. *Slit* oblong, being short and broad; as seen from without, one half is open leading into the interior, the other is closed by the very curved septum. *Margin* crenulated and crimped by the ribs. *Inside* glassy, blunt at the top, not being hollowed into the apex, strongly furrowed by the ribs, less so by the concentric threads; there is no anterior furrow: seen from within, the slit is semioval, and the strong septum is excessively short and straight and is almost perpendicular; from it a slight callus encircles the opening of the slit. L. 0·25. B. 0·16. H. 0·13.

This species in form somewhat resembles *P. agger*, but is more long and narrow; the sculpture and slit are very markedly, and the apex unmistakably, different. In all these respects it differs from *P. Noachina*, L., to the young of which it has a vague resemblance. That species is also in all stages of growth narrower in front than behind. I failed to recognize either the white or transparent specks, one or other of which are so generally present in the Fissurellidæ.

7. PUNCTURELLA PROFUNDI, *Jeffr.* [ACUTA, n. sp.].

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Gwyn Jeffreys, 'Valorous' Gastropoda, Ann. & Mag. N. H. Mar. 1877, p. 232*.

Shell.—Small, thin, roundly oval; the front slope is slightly convex, the others still more slightly concave; the top, of which merely the extreme tip is incurled, projects upwards and a little backwards in a point which is sharpened by the crater-like hole of the slit close in front; minute riblets closely beaded score the surface; the slit is large and round. *Sculpture.* There are very many radiating riblets, which are sharp and distinct but very minute; the surface is also delicately fretted with fine concentric undulations, which in crossing the riblets rise into sharp little contiguous tubercles, but in the narrow intervals are almost invisible. *Colour* frosted glassy-white. *Apex* fine, sharp, prominent, projecting upwards and backwards, with only the extreme tip (which is very small) incurled and slightly turned round; there are fully two whorls. *Slit* is a largish round hole with a pointed prolongation backwards; it lies close in front of the tip, and cuts away the natural top of the shell. *Margin* excessively thin, patulous all round, not crimped. *Inside* glassy; a very small hollow runs into the apex; the lines of the outside ribs are just perceptible; there is no anterior furrow; the slit, as seen from within, is round, and is very little interfered with by the short, thin, triangular, straight-edged, little-oblique septum. L. 0·21. B. 0·16. H. 0·14.

* Dr. Gwyn Jeffreys mentions that this species was also got by the 'Porcupine' in 1870 off the coast of Portugal in from 740 to 1095 fms.

This species extremely resembles *P. profundi*, Jeffr., especially in the shape of the slit and apex and in the general style of sculpture. In form, however, the West-Indian species is lower, and has the whole margin more spread out, so that while the top of the cone is similar, the profiles of the slopes all round are much more concave; the radiating striæ are much sparser; the tubercles on these are smaller and fewer; the concentric striæ are much weaker and less continuous. The internal septum is a little longer and more oblique, and is a little nearer the front, so that the slit is more covered. The apex is so very like as to make me doubt whether a fuller series of specimens might not supply connecting-links between the two forms. And yet even in the apex there are divergencies. Dr. Gwyn Jeffreys (*l. c.*) says that *P. profundi* has "the beak twisted to the left." The tip is bent over to the left so as to lie obliquely on the posterior slope; but the minute embryonic apex lies toward the right hand of the observer, the slit being in front. In the 'Challenger' species the apex is a very little larger, and the spire has about $\frac{1}{4}$ of a whorl more, the earlier rate of increase is slower, and the extreme tip is not so much immersed and is a little more convex. The texture of the shells, too, is different; and, finally, the six 'Challenger' specimens in all these respects agree with one another. On the whole I believe the species to be distinct, but they are certainly very closely allied. [I have now revised this opinion, and united them.]

8. Puncturella oxia, n. sp. (*ὀξύς*, sharp.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Very small, thin, oval, narrowed in front, depressed; its slopes are straight at the sides, slightly and regularly convex in front; merely the extreme tip is curled in, and the top projects sharply upwards and backwards immediately in front of the break of the slit; the surface is closely dotted with minute tubercles; the slit is rather large and round. *Sculpture.* There are neither ribs nor concentric lines, but the surface is pretty closely dotted over with minute rough tubercles, which are arranged in somewhat interrupted and irregular zigzags. *Colour* translucent, and at the tubercles transparent. *Apex* incurved and turned back, but not bent down; there are 2 whorls. *Slit*: there is a largish round hole obliquely cut off from the top, and prolonged backwards into a point. *Margin* very thin, patulous, not crimped. *Inside* glassy; a very small hollow runs up into the apex; the surface is scored with many irregular, minute scratch-like white threads, which are more perceptible on a slightly worn than on a fresh specimen; there is no anterior furrow: the slit, as seen from within, is round, and is very little interfered with by the short, thin, triangular, straight-edged, almost perpendicular septum. L. 0·14. B. 0·1. H. 0·07.

This species has some features of resemblance to the last, but is flatter and in sculpture is quite different.

9. Puncturella sportella, n. sp.

St. 24. March 25, 1873. Lat. 18°38′30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Very small, strongish, oblong, with straight slopes before and at the sides, and markedly concave behind; the apex is very small, and it alone projects backwards; the surface is finely cancellated; the slit is lozenge-shaped. *Sculpture.* There are very many slightly irregular, coarsish, radiating riblets crossed by concentric threadlets, which are rather finer and closer but somewhat more irregular, and which form minute knots in crossing the riblets: from this sculpture results the basket-work appearance from which the name of the species has been adopted. *Colour* white, with a faint tinge of ruddiness. *Apex* is exceedingly minute; and it is the little embryonic spiral alone which projects, the entire number of whorls is only 1¾. *Slit* roundish, but acute in front, and (where closed by the septum) behind drawn out into a sharp point so as to be lozenge-shaped when viewed in its entire length. *Margin* straight on the sides, scarce appreciably broader behind than before; the edge is bevelled off so as to be quite sharp. *Inside* glassy; feebly marked with the ribs which, as well as the concentric threads, shine through as transparent; the opening up into the apex is narrow and deep, but not pointed; there is no anterior furrow; the slit, as seen from within, is roundish pointed in front, and truncated behind by the short, thin, triangular, straight-edged, little-oblique septum. L. 0·12. B. 0·08. H. 0·06.

This beautiful species is not improbably full-grown, the very small apex seeming to indicate that the species is in its own nature minute. In outline it somewhat resembles *P. tuberculata*; in sculpture it has relations with *P. craticia* and *P. acuta*, in both respects it may be compared with *P. plecta*, but is unlike them all, and may be readily recognized by its minute apex.

10. Puncturella (Fissurisepta) rostrata, *Seg.* [acuminata, n. sp.].

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, north of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Seguenza, 'Pal. Malac. Terr. Terz. di Messina,' p. 10, pl. v. f. 3.

Shell.—Very small, thin and high, ovate, with slightly impressed sides, glassy, dotted in regular oblique-curving lines, with high, blunt, minute glassy tubercles; the side slopes are high and straight, the front edge faintly convex, the back slope slightly concave; there is no embryonic apex; and the slit is a round hole parallel to the base. *Sculpture.* The surface of the shell is glassy, but is dotted with minute tubercles which are generally parted by more than their own diameter, and run in very regular oblique sweeps parallel to one another. *Colour* transparently glassy, the tubercles being dead white. *Apex* none, the top being slightly bent back and the entire tip removed. *Slit*: a small round hole in the very top, with slightly irregular sides. *Margin* very thin; the sides are almost straight or a little bent in, and the breadth is very slightly greater behind than before. *Inside* quite glassy; there is no anterior furrow, and the straight concave-edged septum runs far down the shell parallel, and very near to the posterior wall, thus cutting off a long sheath-like process. L. 0·13. B. 0·08. H. 0·12.

This is a most exceptional and peculiar little species, quite unlike any other known to me.

Fam. Cocculinidæ, *Dall.*

Gen. Cocculina, *Dall.*

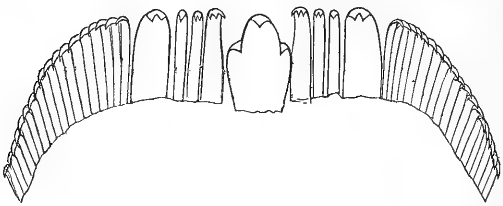
Cocculina angulata, n. sp.

St. 203. Oct. 31, 1874. Lat. 11° 7′ N., long. 123° 7′ E. Philippines. 20 fms. Mud.

Shell.—Small, thinnish, with a strongish membranaceous epidermis, compressedly patelliform, oval, with a long convex anterior slope, a short slightly concave posterior slope, while the compressed side slopes are very steep and very slightly convex;

there is a blunt reverted tip, but no embryonic shell; the surface is rayed with five smooth, rounded, unequal riblets. *Sculpture.* Longitudinals—from the top proceed radiating riblets, which are regular, delicate, well rounded, raised and unequal, a few being a little stronger than the rest which, to the number of two to four, closely occupy the intervals. Spirals—these are microscopic, rounded, close-set, and very faint. *Colour*: under the strongish, hard, membranaceous, pale brownish epidermis the shell is porcellaneous white. *Apex*: the embryonic apex has been removed, and a scarred plug at the very top of the back slope fills the hole it left. *Margin* thin and broken, and overlapped by the epidermis. *Inside* porcellaneous, delicately fluted, open to the apex, with a strongish horse-shoe scar, with two oval muscular impressions, and the prominent head-scar shaped like that in *Patella*, only somewhat larger in proportion. L. 0·13. B. 0·07. H. 0·07.

I dissected the animal of this species with great care, but not much satisfaction, the specimen being extremely small and necessarily somewhat damaged by preservation in spirit. No eyes could be seen; but as their absence on the surface is sometimes due to a power of internal withdrawal, I looked for them carefully during dissection, but in vain. There were no appendages to the side of the foot or on the mantle-edge, a feature on which Mr. Dall dwells in establishing the genus. He describes the branchia as a single asymmetrical gill, but plumose. In the 'Challenger' species there was no appearance of a plume, but a somewhat stumpy finger-shaped process projected backward from the lower right side of the neck; and from the side of this process another, very much smaller, issued in the same direction. The surface of both these (and of them alone) was finely tessellated or beaded; and in each bead there seemed to be the loop of a blood-vessel. The dentition is, as Mr. Dall observes, very like that of *Scutus australis*, Quoy, given in Gray's 'Guide,' p. 163, so far, that is, as general arrangement and relation is concerned; but in *Cocculina angulata* the centre tooth is higher and narrower, with a much smaller cusped point, and is shouldered at either side; the three following laterals on either side in form and position are like those given by Gray at p. 190 (not p. 172), f. 103, as those of *Lepeta cæca*, only that the inmost one has three, the second two, and the third one cusp. Thus far, therefore, Gray's figure of *Lepeta cæca*, p. 190, agrees better, so far as it goes, with the toothing of *Cocculina angulata*; but beyond the three small laterals occurs a single largish bicuspid tooth, not nearly so formidable a weapon as that of *Scutus australis*, which is enormously larger, more curved, and tricuspid. Beyond these, as in Gray's figure, but very much more numerous and more crowded, are an infinity of small hooked laterals. Attaching very little value to systems of classification of Mollusca based on dentition, I should have hesitated to follow Mr. Dall in separating this group from *Lepeta*; but there is one fact which probably is a sufficient reason for a step otherwise much to be deplored, viz. that in *Cocculina* the long slope of the shell is in front, a feature which the genus shares with *Propilidium* in common with the whole of the "Fissured Limpets," and which contradicts the common rule for the unfissured Limpets, that the short slope is in front.



Dentition of *Cocculina angulata*, Wats., highly magnified.

Observations on Ants, Bees, and Wasps.—Part X. With a Description of a new Genus of Honey-ant. By Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S.

[Read November 2, 1882.]

(Plate II.)

On Bees.

Dr. Müller's Criticisms.—A recent number of 'Kosmos' contains a very courteous and complimentary notice, by Dr. H. Müller, of my recent book on Ants, Bees, and Wasps, which of course, coming from so high an authority, is especially gratifying. Dr. Müller, however, criticises some of the experiments by which I think I have shown experimentally that bees are attracted by different colors, and that they prefer blue to red, yellow, white, or green.

He remarks that in order to make the experiment absolutely correct, the seven glasses should have been arranged in every possible order, and that this would give no less than 5040 combinations. I did not, however, suppose that I had attained to mathematical accuracy, or shown the exact degree of preference; all I claimed to show was the order of preference; and I think that as in my experiments the position of the colors was continually being changed, the result in this respect would have been substantially the same.

Dr. Müller also observes that when a bee has been accustomed to come to one place for honey, she returns to it, and will tend to alight there whatever the color may be; and he shows, by the record of his own experiences, that this has a considerable influence. This is so. Of course, however, it applies mainly to bees which had been used for some time, and were accustomed to a particular spot. I was fully alive to this tendency of the bees, and neutralized it to a considerable extent, partly by frequently changing the bee, and partly by moving the glasses. While, however, I admit that it is a factor which has to be taken into consideration, I do not see that it is any argument against my conclusions. The tendency would be to weaken the effect of preference for any particular color, and to equalize the visits to all the glasses. This tendency on the part of the bees was, as my experiments show, overborne by the effect produced upon them by the color. So far from weakening my conclusions, the fact, so far as it goes, tends to strengthen them, because it shows that notwithstanding this tendency the blue was preferred and the honey on colorless glass neglected. The legitimate conclusion to be drawn seems, I confess, to me, not that my mode of observation was faulty, but only that the preference of the bees for particular colors is really somewhat greater than the numbers would indicate.

Next, Dr. Müller objects that when disturbed from one drop of honey, the bees naturally would, and that in his experiments they actually did, fly to the next. He gives the two following cases in illustration:—

Blue.	Yellow.	Greenish yellow.	Scarlet.	White.	Red.	Green.	Violet.
	7	6	5	4	3	2	1

Violet.	Green.	Red.	White.	Scarlet.	Greenish yellow.	Yellow.	Blue.
8	7	6	5	4	3	2	1

in which, as will be seen, the bee came in both cases to the right-hand drop, and then went regularly along the line, whatever the color might be. Out of 240 cases he found that the bee, when disturbed, flew to the nearest drop in 207. As a matter of fact, however, this did not happen in my experiments, because, to avoid this source of error, when I removed the colour I gave the bee a good shake and so made her take a flight before settling down again.

According to my experience, bees differ considerably in character, or, I should rather perhaps say, in humor. Some are much shier and more restless than others. When disturbed from the first drop of honey, some are much longer before they settle on the next than others. Much also of course depends on how long the bee has been experimented on. Bees, like men, settle down to their work. Moreover it is no doubt true that, *cœteris paribus*, a bee in search of honey will go to the nearest source.

But, as a matter of fact, in my hundred experiments I only had a few cases like those quoted above from Dr. Müller. This arose partly from the fact that my bees were frequently changed, and partly because I took care, in removing the color, to startle the bee enough to make her take a little flight before alighting again. Dr. Müller says that in his experiments, when the bee did not go to the next honey, it was when he shook her off *too* vigorously. Under the circumstances, I should rather say that in the two observations quoted above he did not shake the bee off vigorously enough. The whole objection, however, is open to the same remark as the last. The bee would have a tendency of course, like any one else, to go to the nearest honey. Hence I never supposed that the figures exactly indicate the degree of preference. The very fact, however, that there would naturally be a tendency to save themselves labor by going to the nearest honey, makes the contrast shown by my observations all the more striking. Dr. Müller's criticism does not in any way invalidate my conclusions, as he supposes, but, as it seems to me, strengthens my argument.

I have never alleged that it was possible in the case of bees (or for that matter of men either) to get any absolute and exact measure of preference for one color over another. It would be easy to suggest many considerations which would prevent this. For instance, something would probably depend on the kind of flower the bee had been in the habit of visiting. A bee which had been sucking daises might probably behave very differently from one which had been frequenting a blue flower.

So far, however, as the conclusions which I ventured to draw are concerned, I cannot see that they are in any way invalidated by the objections which Dr. Müller has urged.

I exhibit to the Society my original notes; and it will be seen that there is no such sequence as Dr. Müller supposes.

I am glad to see that Dr. Müller is himself about to make a series of experiments on bees with reference to color; and I doubt not they will be most interesting.

Hearing in Bees.—Aug. 27. I brought two sets of bees from different hives to two deposits of honey a few yards apart, and after arranging a telephone with a microphone in the circuit, disturbed one set of bees, holding a telephone close over the other, to see if they would make any noise which would affect the others. I tried it several times, but with no result.

I then placed one telephone just at the entrance of the hive; but whether the apparatus was connected or not, and whether the bees were disturbed or not, seemed to make no difference.

I then made the following experiment:—On the 30th September I put out a small quantity of honey on my lawn and brought some bees to it. I then set a musical box going, and continually replenished the honey and wound up the box. The weather was lovely, and all day a certain number of bees visited the honey.

Then on the 8th October I removed the honey to an open window on the first floor, and set the musical box playing as usual by its side. I waited half an hour, but not a bee came. I need hardly say that the music was quite audible on the lawn. I then again put the musical box and the honey on the lawn, and the bees very soon again began work. After the lapse of an hour I brought the honey and musical box into the house, and placed them at an open drawing-room window less than 15 yards from where they had stood on the lawn. The music was kept going for an hour, but not a bee came.

The following day was again extremely fine. The bees came as usual to the honey. I let them feed till 10 A.M., when I removed the honey as before to the drawing-room. After the lapse of half an hour I set the box playing and waited half an hour, but not a bee came.

I then put the honey and musical box again out on a chair on the lawn 5 yards in front of the drawing-room window. The first bee found the honey in $5\frac{1}{4}$ minutes. I left it so for three quarters of an hour, and then brought the honey and the musical box into the house and put them just inside the window but out of sight. The box was kept playing for three quarters of an hour, during the whole of which a few bees kept hovering round the chair; but not a single bee found the honey, or even was attracted by the music into the room. I then took the honey and put it again on the chair outside. In less than 5 minutes nine bees had settled on it. I then brought it back into the room and put it, with the bees on it, where it had stood previously. The bees fed, returned to the hive, and came back again to the honey as usual, showing that they had not the slightest objection to enter the house.

I then took the honey and the musical box down to the hives. Immediately (*i. e.* about a yard) in front of my hives is a low wall; and I put the box and the honey on the far side of the wall, so that they were something less than 4 yards distant from the hive, but of course not directly visible. I then kept the music going for two hours, from 1.30 to 3.30 P.M., but not a bee came to the honey.

From these experiments we are, I think, justified in concluding either that the bees did not hear the music, or that, though they had been feeding close to the music, eight days was not a long enough period to suggest to them that there could possibly be any connexion between the honey and the musical box.

To decide between these two alternatives, I moved the musical box (without setting it to play) and honey to another part of the lawn about 15 yards from the first, and put an equal quantity of honey on a similar piece of glass at about the same distance both from the musical box and from the spot where the box had previously been. In half an hour there were several bees at the honey on the musical box, and none at the other. After this we had a week of rain. The next fine morning I again put out the musical box with some honey, and at a distance of about 15 yards a similar quantity of honey on a bit of glass on the grass. In half an hour there were several bees at the honey on the musical box, and none on the other.

I had intended to repeat this several times for greater security, but was unfortunately prevented by bad weather. The observations, however, indicate, as far as they go, that the bees did connect the presence of the musical box with that of the honey, and were guided by it, even if it were not playing, so long as they could see it, but that if they could not see it, even though it were playing, it did not assist them.

At first sight it might seem that these experiments are in direct opposition to the general idea, that a clanging noise is useful in causing bees when swarming to settle soon. This notion is as old as Aristotle, who says, " Bees also appear to have pleasure in noises, so that they say that they collect them into their hives by striking earthen vessels and making noises." He adds, however, " But it is very doubtful whether they hear or not."

The general opinion among writers on bees now seems to be that " tanging " is quite unecessary. Bevan says:—"A tinkling noise is generally, though erroneously, considered to be useful in inducing bees to settle; it is usually made by drumming smartly upon a frying-pan with a large key; and the cottagers call it 'tanging' or 'ringing.' It was probably practised, 'at first,' as Butler says, 'to proclaim to the neighbours that a swarm was up, serving as a public notification of the hive from whence it proceeded. This view of the matter is confirmed by the opinion prevalent in some districts, that unless the apiarian can prove the tanging, he cannot justly lay claim to the swarm if it happen to cluster on the premises of a neighbour. The original object of this proceeding, however, seems to be forgotten; and the practice is regarded by most of the cottagers as quite necessary to effect a speedy and satisfactory settling of the bees. Most scientific apiarians discountenance it; and I am convinced that it is wholly useless.' Mr. Dunbar, during a period of nearly forty years, has only lost one swarm; and that, contrary to his own judgment, was most sonorously tanged"*.

I cannot from my own experience decide the point. Admitting, however, that a custom so ancient and so widely spread, is unlikely to be entirely without foundation, I would suggest as possible that what the bees hear under these circumstances are not the sounds which affect us, but the high upper tones near and beyond our range of hearing. Mr. G. Darwin and Lord Rayleigh, whom I have consulted on the subject, inform me that the presence of these inaudible overtones is unquestionable. Mr. Darwin says:—"The high overtones (generally non-harmonic overtones) are very strong within the limits of audibility; and it is almost certain, though not experimentally verified, that the overtones beyond the limits of audibility are strong also."

On Wasps.

Industry of Wasps.—The statement that wasps are as industrious as bees has been received with some incredulity, and has been by many regarded rather as a perhaps pardonable exaggeration arising from individual partiality, than as the strict and sober truth.

I thought therefore that it would be interesting to compare a wasp and a bee under similar circumstances for a whole day. Accordingly, on the 6th August I accustomed a wasp and three bees to come to some honey put out for them on two tables, one allotted to the wasp, the other to the bees. The last bee came at 7.15 P.M. The wasp continued working regularly till 7.47, coming at intervals of between 6 and 7 minutes. Next morning, when I went into my study a few minutes after 4 A.M., I found her already at the honey. The first bee came at 5.45; the second at 6.

The wasp occupied about a minute, or even less, in supplying herself with a load of honey, and made during the day, as shown below, no less than 116 visits to the honey, or 232 journeys between my room and her nest, during which she carried off rather more than 64 grains of honey. The bee sucked from 6 to 16

* 'The Honey-bee,' by Ed. Bevan, p. 91.

minutes, and made 29 visits to the honey. Next morning she made her first visit at 8.

As regards the wasp, I believe the record gives a fair idea of what an average wasp would do under similar circumstances. The bee, however, was a shy one; and, as shown in previous experiments, most bees would have come much more frequently. As regards the time she commenced and ceased work, however, she kept about the usual hours, and, as will be seen, began later and left off earlier than the wasp. It would, however, perhaps be unfair to the bees to regard this as indicating that they are less industrious than wasps. The difference may be due to their being more susceptible to cold.

Wasp.	Bee, L. W.	Wasp.	Bee, L. W.	Wasp.	Bee, L. W.
4.13		8.40		12.52	
4.32		8.45		12.56	
4.50		8.56		1. 4	1. 5
5. 5		9. 7		1.11	
5.15		9.14		1.20	
5.22		9.20		1.25	1.25
5.29		9.26		1.30	
5.36		9.37		1.35*	
5.43	5.45	9.43		1.43	1.40
5.50		9.50		1.48	
5.57	5.58	9.57		1.53	1.53
6. 5		10. 4		2	
6.14		10.10		2. 7	
6.23		10.15		2.12	
6.30	6.35	10.24		2.23	2.25
6.40		10.29		2.33	
6.48		10.37		2.39	2.41
6.56		10.45		2.45	2.45
7. 5	7. 4	10.50		2.55	
7.12		10.59		3. 2	3
7.18		11. 6		3. 9	3·16
7.25		11.15		3.17	
7.31		11.22		3.25	
7.40	7.41	11.30		3.30	3.32
7.46		11.35		3.37	
7.52		11.47	11.45	3.45	
8		11.55		3.55	
8.10	8.11	12. 6		4. 5	4
8.18		12.14	12.15	4.12	
8.24		12.22	12.25	4.19	4.16
8.29		12.36	12.37	4.28	
8.36	8.35	12.46		4.39	4.38

* She came and a strange one followed; they began to fight, and I separated them.

Wasp.	Bee, L. W.	Wasp.	Bee, L. W.	Wasp.	Bee, L. W.
4.46		5.50	5.50	6.55	
4.56		6. 5		7. 7	
5. 3	5	6.12		7.17	7.15
5.14		6.20		7.30	
5.25	5.20	6.30		7.36	
5.35		6.40		7.46	
5.46		6.46	6.50		

After this I was away from home for six days, returning on the 12th. During the interval I left the honey on the table, covered over, but with a small entrance for the wasp. On my return I found her still industriously at work. The following morning I got up at 3; but that morning she did not make her first visit till 5.10, returning at 5.19. No other wasp came to the honey.

On Ants.

Ants, Recognition by.—With reference to the interesting problem as to how ants recognize their nest companions, I mentioned in my last paper that I had tried the following experiment.

took a few specimens of *Formica fusca* from two different nests, which I will call A and B, and placed them together. At first they were rather shy; but after awhile they fraternized. After they had lived amicably together for three months, I put two of these ants from nest A into nest B; but they were soon attacked vigorously and driven out of the nest.

I have now repeated and extended this test.

On the 16th June I put three specimens of *F. fusca* from my nest No. 81, with the same number from nest 71. Then on the 19th September, one of the six having died in the interval, I put the two from nest 81 into nest 71, and the three from nest 71 into 81. They were all attacked, though not very quickly or vigorously, but by the 21st September all five had been expelled.

Again, on the 25th September I took three ants from each of these nests and put the six together. Then on the 19th March following, one having again died, I put the two from 71 into 81 and the three from 81 into 71. They were all attacked; so that they were evidently recognized as strangers; but it seemed to me that the attack was less vigorous, and I could not be sure that they were either killed or driven out. In the course of the week three or four dead ants were brought out of each of the nests;

but I could not feel quite sure that they were those experimented with.

Lastly, on the 9th April I again put twelve ants, six from each of these nests, together, and kept them so till the 22nd October. I then took four of those from 71, put three into 81 and the fourth into 71. I also took four of those from 81, and put three into 71, and the fourth back into 81 among her old friends. The two ants thus restored respectively to their old nests were as usual recognized as friends and quite unmolested. As regards the other six, the results were as follows. The ants were introduced into the nests at 8.15 A.M.

	Nest 71.	Nest 81.
8.45.	One was being attacked.	One was being attacked.
9.15.	None were " "	" " "
9.45.	Two were " "	" " "
10.15.	One was " "	" " "
10.45.	None were " "	" " "
12.30.	Two were " "	" " "
1.30.	Two were " "	None were " "
2.30.	One was " "	" " "

I do not give these results as by any means proving that ants do not recognize their friends by means of smell. They do seem, however, to show that not even six months of close companionship under precisely similar conditions will so far assimilate the odour as to lead to confusion. If the recognition *is* due in any degree to this cause, the odour is therefore probably an hereditary characteristic.

The following little fact may be worth mentioning as bearing both on the power of communication possessed by ants, and also on their feeling towards a queen. I was starting a new nest of *Lasius flavus* in which were two queens. We allowed the ants to take one of them into their new glass house; the other we kept with a small retinue in a separate bottle. If this bottle is placed near the nest, some of the retinue leave it, go into the nest, and soon the ants come out in large numbers to see, I had almost said to pay their respects to, their queen.

Longevity of Ants.—In previous papers I have called attention to the considerable age attained by my ants; and I may perhaps be permitted to repeat here, *mutatis mutandis*, a paragraph from my last communication with reference to my most aged specimens, most of those mentioned last year being still alive. One of my nests of *Formica fusca* was brought from the woods in December 1874; it then contained two queens, both of which are now still alive. I am disposed to think that some of the workers now in the nest were among those originally captured, the mortality after the first few weeks having been but small. This, of course, I cannot prove. The queens, however, are certainly more than eight, and probably now more than nine years old. In the nest of *Lasius niger* which I brought in on the 30th November 1875 there was no queen, and, as already mentioned, no workers have been produced. These two still living are therefore the original ones; and they must be between seven and eight years old *.

I had also some workers of *Lasius niger* which I began to observe on the 6th July 1875; the last of these died on June 15th, 1881.

Lastly, some of *Formica cinerea*, which I began to observe on the 29th November 1875, lived till the ants in this nest died off somewhat rapidly, the last on July 23, 1881. There were no queens in either of these nests; these workers therefore must have been more than six years old. The workers of *Lasius niger* above mentioned, which were born at latest in the spring of 1875, must now be more than seven, and my two queens of *F. fusca* more than eight years old.

Sensitiveness of Ants to the Ultra-violet Rays.—Mr. Wigner (of Messrs. Harland and Wigner) was good enough to prepare me a solution of iodine in bisulphide of carbon, and a second of indigo, carmine, and roseine mixed so as to produce the same tint. To our eyes the two were identical both in color and capacity; but of course the ultra-violet rays were cut off by the bisulphide-of-carbon solution, while they were, at least for the most part, transmitted by the other. I placed equal amounts in flat-sided glass bottles, so as to have the same depth of each liquid. I then laid them as in previous experiments over a nest of *Formica fusca.* In twenty observations the ants went seventeen times all under the iodine and bisulphide, twice under the solution of indigo and carmine, and once there were some under each. These observations therefore show that the solutions, though apparently identical to us, appeared to the ants very different, and that, as

* They are now dead, the last on the 25th of February. The two queens of *F. fusca* are (March 1883) still alive.

before, they preferred to rest under the liquid which intercepted the ultra-violet rays. In two or three cases only they went under the other bottle; but I ought to add that my observations were made in winter, when the ants were rather sluggish. I am disposed to think that in summer perhaps these exceptional cases would not have occurred.

Discovery of Ponera *in Britain.*—Lastly, I have to record the discovery by my daughters' governess, Miss Wendland (whose assistance I have already had occasion to acknowledge), of a nest of *Ponera contracta*, the first, I believe, ever found in this country. By an unfortunate accident a community of *Lasius flavus* obtained access to and destroyed them before I was able to make any observations on them. Their nest was under a stone; and the community consisted of about 20 individuals.

Description of a New Honey-Ant.

Mr. Bagot has been good enough to send me from Australia another species of Honey-ant, which appears to form the type of a new genus, which I proposed to myself to dedicate to M. Forel and to its discoverer. I am, however, unfortunately anticipated in the use of *Forelia* as a genus, it recently having been appropriated by Dr. G. Haller for a new form of Swiss Hydrachnidæ (see Mitt. naturforsch. Gesell. Bern, 1882, p. 18). In the preparation of the description, which I subjoin, M. Forel has been good enough to give me his valuable assistance.

Melophorus, gen. nov. (Plate II. figs. 1–10.)

Operaria inflata.—Long. 18 mill. Caput rectangulare, latius quam longius. Mandibulæ angustæ, striatæ, quinquedentatæ, dentibus irregularibus, dente anteriore longissimo. Clypeus brevis, subcarinatus, margine antico angulato, ciliato. Fovea clypei magna. Area frontalis triangularis, lata. Ocelli minuti. Oculi ad partem tertiam posteriorem capitis longitudinis (antice) siti. Sulcus magnus inter pronotum et metanotum. Metathorax late constrictus. Petioli squama verticalis, modice incrassata, antice convexa, postice plana, margine superiore emarginato. Subtiliter coriacea, rugulosa, subnitida; fronte inter laminas longitudinaliter rugulosa; abdomine nitido subtilissime transversim ruguloso. Sparsissime pilosa, capite infra setis longis barbato. Pubescentia corporis sparsissima, vix ulla. Femora subadpresse breviter pilosa. Tibiæ setis brevibus crassis spiniformibus. Testaceo-rufescens, abdomen testaceum, mandibulæ rufo-castaneæ, apice castaneo-nigro.

Habitat Australiam; lat. 21° S.

Melophorus bagoti, sp. n.

Operaria.—Antennæ 12-articulatæ, articulis basalibus longioribus, apicalibus (ultimo excepto) brevioribus; palpi maxillares sexarticulati, labiales quadriarticulati; antennæ oriuntur ab angulis clypei posticis; fovea antennalis cum fovea clypei partim confluens; area frontalis lata; laminæ frontales distantes, breves, rectæ; clypeus brevis, antice ciliatus; mandibulæ angustæ, dentatæ; ocelli tres; metathorax constrictus; petioli squama verticalis; abdomen orificio cloacæ rotundo, ciliato, apicali; vesicula venenifica cum pulvinari; gigeriorum lamellæ breves, a basi fortiter divergentes.

DESCRIPTION OF PLATE II.

Fig. 1. Outline figure of a slightly swollen specimen of the new Australian Honey-ant, *Melophorus bagoti*, three times natural size.
2. The head, seen from above, ×10.
3. Antenna, ×10.
4. Mandible, ×10.
5. Labium, ×14.
6. Maxilla, ×14.
7. Labrum, ×10.
8. Knot, seen from behind, ×10.
9. An outline of the thorax, viewed laterally, ×10.
10. An outline of the thorax, seen from above, ×10.

Remarks on the Genera of the Subfamily Chalcidinæ, with Synonymic Notes and Descriptions of new Species of *Leucospidinæ* and *Chalcidinæ*. By W. F. Kirby, Sec. Entomol. Soc., Assist. Zool. Depart. Brit. Museum. (Communicated by Dr. Günther, F.R.S., F.L.S.)

[Read December 7, 1882.]

(Plates III. & IV.)

Introductory Remarks.

The subfamily Chalcidinæ is in a very unsatisfactory state; and the tendency of recent authors has been to class the majority of the species under the three genera *Smicra*, *Halticella*, and *Chalcis*, ignoring the divisions which former writers have proposed, partly on the ground that several of their genera run into each other, and partly because it is usually considered that characters taken from one sex only are not sufficient to establish a genus. But in the order Hymenoptera, where the females frequently far outnumber the males, forming in fact the bulk of the species, it appears to me that the latter objection will hardly hold good. Although Walker described a great number of Chalcidinæ from the Amazons and other localities, yet he founded his species in most cases on single specimens, in which case, of course, there is only one sex (generally the female) known. Under these circumstances, I thought it might be useful to discuss all the genera of Chalcidinæ more or less in detail, establishing new ones for any unnamed sections which appeared to be sufficiently well defined, as preparatory to a thorough revision of the subfamily by myself, or some other entomologist, when a larger amount of material has accumulated. In the case of known genera, I usually confine myself to stating essential characters, and to indicating their types. The number of joints of the antennæ here given will sometimes be found to differ from that stated by previous authors. This is frequently a very difficult character to verify; but I have subjected every specimen figured to a careful microscopic examination, with the kind assistance of Mr. E. Wilson, and I think the results may be relied on as correct.

List of Genera included in the present paper with indications of Types.

A. Petiole more or less distinct.

1. Smicra, Spin. (*Chalcis sispes*, L.).
2. Spilochalcis, Thoms. (*C. xanthostigma*, Dalm.).
3. Epitranus, Walk. (*E. fulvescens*, Walk.).
4. Chalcitella, Westw. (*C. evanioides*, Westw.).
5. Anacryptus, Kirb. (*Epitranus impulsator*, Walk.).
6. Arretocera, Kirb. (*Ep. albipennis*, Walk.).
7. Thaumapus, Kirb. (*Smicra decora*, Walk.).
8. Dirrhinus, Dalm. (*D. excavatus*, Dalm.).
9. Eniaca, Kirb. (*Chalcis cornigera*, Jur.).
10. Axima, Walk. (*O. spinifrons*, Walk.).

B. Petiole extremely short.

11. Agamerion, Hal. (*Miscogaster gelo*, Walk.).
12. Notaspis, Walk. (*N. formiciformis*, Walk.).
13. Epinæus, Kirb. (*Smicra dux*, Walk.).
14. Conura, Spin. (*C. flavicans*, Spin.).
15. Stypiura, Kirb. (*Chalcis conigastra*, Perty).
16. Phasgonophora, Westw. (*P. sulcata*, Westw.).
17. Trigonura, Sich. (*Phasg. crassicauda*, Sich.).
18. Aspirrhina, Kirb. (*Halticella dubitator*, Walk.).
19. Proctoceras, Kirb. (*Smicra leucotelus*, Walk.).
20. Thamnotelia, Kirb. (*Chalcis separata*, Walk.).
21. Epitelia, Kirb. (*Chalcis stylata*, Walk.).
22. Megalocolus, Kirb. (*Halticella ducator*, Walk.).
23. Pseudochalcis, Kirb. (*H. declarator*, Walk.).
24. Trichoxenia, Kirb. (*H. cineraria*, Walk.).
25. Stomatoceras, Kirb. (*H. liberator*, Walk.).
26. Antrocephalus, Kirb. (*H. fascicornis*, Walk.).
27. Euchalcis, Duf. (*E. Miegii*, Duf.).
28. Neochalcis, Kirb. (*Halt. osmicida*, Saund.).
29. Hockeria, Walk. (*Chalcis bispinosa*, Fabr.).
30. Halticella, Spin. (*C. pusilla*, Fabr.).
31. Hybothorax, Ratz. (*H. Graafii*, Ratz.).
32. Hippota, Walk. (*Chalcis pectinicornis*, Latr.).
33. Chalcis, Fabr. (*Vespa minuta*, Linn.).

The Genera of Chalcidinæ.

1. Smicra. (Plate III. figs. 1–3.)

Smiera (err. impr.), Spin. Ann. Mus. xvii. p. 147 (1811).

Types *Chalcis sispes*, Fabr. (=*myrifex*, Sulz.), and *clavipes*, Fabr. (=*sispes*, Linn.), from Europe.

Antennæ 12- or 13-jointed, inserted in the middle of the face; scutellum more or less distinctly bidentate; abdomen subglobose, about twice as long as broad, and about twice as long as the petiole, which is rather thick; middle tibiæ not spined; hind tibiæ produced to a point; hind femora dilated, dentated beneath, with one large tooth at the base, followed by seven smaller ones (*sispes*, L.) or two large basal teeth, almost side by side, followed by a series of very minute ones (*myrifex*, Sulz.).

I prefer to leave the European species together for the present, though they are hardly congeneric.

2. Spilochalcis. (Plate III. figs. 4–5.)

Spilochalcis, Thoms. Hym. Scand. iv. p. 15 (1876).

Type *Chalcis xanthostigma*, Dalm. Vetensk. Handl. 1820, p. 141, from Northern Europe.

Antennæ pubescent, rather short and stout, scape rather short; middle tibiæ spined and hind tibiæ truncated at the extremity; hind femora armed with many minute blunt teeth.

3. Epitranus. (Plate III. figs. 6–7.)

Epitranus, Walk. Ent. Mag. ii. p. 26 (1834).

Type *E. fulvescens*, Walk., from St. Vincent's.

Antennæ 14-jointed, scape one third of their length, and somewhat clavate at tip; flagellum gradually thickened nearly to the extremity, terminal joint conical, pointed; head convex in front as far as the antennal tubercles; ocelli arranged in a triangle; thorax and scutellum thickly covered with large punctures, the latter rounded behind; petiole half as long as the abdomen, stout, and apparently channelled below; the first segment occupying nearly the whole of the abdomen, which is pointed at the tip; hind femora thickened, armed with some small teeth; hind tibiæ armed before the tip with a long curved spine.

The species subsequently referred by Walker to *Epitranus* are not congeneric.

4. Chalcitella.

Chalcitella, Westw. P. Z. S. 1835, p. 70.

Type *Chalcitella evanioides*, Westw., from Mauritius.

"Antennæ ad os insertæ 12?–13? articulatæ, articulo 2do brevi, 3tio et sex sequentibus paullo majoribus, valde continuis, reliquis tribus vel quatuor massam elongato-conicam efformantibus. Metathorax valde declivis. Pedunculus dimidium abdominis longitudine æquans, gracilis, cylindricus. Femora intermedia ad basin gracilia, ad apicem subclavata; coxæ posticæ crassæ, longæ; femora postica maxima, subtus 7-dentata.

"Obs. Genus *Chalcidibus* typicalibus (ex. gr. *sispes*) affine."

5. Anacryptus. (Plate III. figs. 8–9).

Type *Epitranus impulsator*, Walk. Trans. Ent. Soc. Lond. (3) i. p. 348 (1862), from Makassar.

Antennæ inserted near the mouth, 13-jointed, rather short and of moderate thickness, slightly attenuated beyond the scape, and clothed with very fine down; scape about half as long as the flagellum; joints 2 and 3 small, joints 4–12 of about equal length, each as long as joints 2 and 3 together, joint 13 very small, conical; head excavated as far back as the ocelli, and hinder edge of the scutellum also strongly concave; scutellum unarmed; abdomen petiolated, petiole moderately stout, fully as long as the abdomen; hind coxæ very large, nearly as long as the petiole; hind femora comparatively narrow, and strongly punctured, serrated beneath, and with a large tooth near the base; hind tibiæ with a large obtuse tooth near the base on the outside.

This genus must be closely allied to *Chalcitella*, Westw., but may be distinguished by the peculiar structure of the hind tibiæ.

6. Arretocera. (Plate III. figs. 10–11.)

Type *Epitranus albipennis*, Walk. Trans. Ent. Soc. Lond. 1874, p. 400, from Hiogo, Japan.

General structure of *Epitranus*; head narrower; antennæ 13-jointed, inserted near the mouth; scape about two fifths of the total length; flagellum short and rather thick, slightly pilose, second joint rather long, third very short, the next nine of about equal length, apical joint small, conical; hind femora armed with many very minute teeth.

The single specimen is carded in such a manner as to render a proper examination of the antennæ very difficult.

7. Thaumapus. (Plate III. figs. 12–14.)

To include *Smicra masus*, Walk. Ent. i. p. 134 (1841); *S. decora*, Walk. Notes Chalc. iii. p. 54 (1871); and one new species. *S. decora* may be regarded as the type.

Antennæ 12-jointed, inserted low on the face; scape one sixth of the total length, second joint bare, the rest very pilose and of nearly equal thickness throughout, the last three very short, the last subtruncate; scutellum bidentate; metathorax with two large teeth on each side; petiole half the length of the abdomen, which is subglobose; hind coxæ stout, much longer than the petiole; hind femora armed with moderate-sized teeth; wings more or less clouded, with the nervures very strongly marked.

8. Dirrhinus. (Plate III. figs. 15–17.)

Dirhinus, Dalm. Vet. Akad. Handl. 1818, p. 75.

Dirrhinus, Dalm. Anal. Ent. p. 29 (1823).

Type *D. excavatus*, Dalm. *ll. cc.*, from Sierra Leone.

Antennæ 12-jointed, inserted in the middle of the face, gradually thickened nearly to the extremity; head very deeply excavated, with a long projection in front within the eyes; scutellum unarmed, but metathorax strongly bidentate behind.

The details figured are taken from a specimen without locality, which agrees with Klug's figure of *D. excavatus* from Egypt (Symb. Phys. pl. xxxvii. fig. 14). Whether it is identical with Dalman's insect from Sierra Leone cannot be ascertained in the absence of specimens from the latter locality.

9. Eniaca. (Plate III. fig. 18.)

Dirhinus, Walk. (nec Dalm.), Ent. Mag. ii. p. 38 (1834).

Type *Chrysis* (?) *hesperidum*, Rossi, Faun. Etr., ii. p. 78 (1790), from Europe.

Differs from *Dirrhinus* by its 13-jointed antennæ, with a long slender scape and thicker flagellum.

10. Axima. (Plate III. fig. 19.)

Axima, Walk. Trans. Ent. Soc. Lond. (3) i. p. 373 (1862).

Type *A. spinifrons*, Walk. *l. c.*, from the Upper Amazons (St. Paulo).

Body long and slender; head very broad; eyes very prominent, making the head considerably broader than the thorax; a short sharp spine projecting in front within each eye, and a shorter and blunter one outside each antenna; head and thorax scabrous: antennæ 11-jointed, inserted close together in the middle of the face; scape moderately long, bare, followed by three small bare joints; the remaining joints well separated, and clothed with short bristles, the fourth considerably longer than the remainder: scutellum, metathorax, and hind femora unarmed; abdomen petiolated, very long, slender and tapering, petiole about one fourth of its length; legs long and slender; hind femora rounded and very slightly thickened.

An anomalous genus, of somewhat uncertain position. In spite of its structural analogy to *Dirrhinus*, it would perhaps be better to remove it from the Chalcidinæ to the Cleonyminæ, and place it near *Epistenia*, &c.

11. Agamerion. (Plate III. figs. 20, 21.)

Agamerion, Hal. Trans. Ent. Soc. Lond. iii. p. 298 (1843).

Type *Miscogaster gelo*, Walk. Mon. Chalc. ii. p. 27 (1839), from Sydney.

Head as broad as the thorax; eyes large; antennæ pubescent, 12-jointed, far apart at the base, inserted below the eyes, joints 3 and 12 minute; scutellum with a projecting point; abdomen sessile, ovate (conical in female); coxæ and hind femora much thickened, and slightly keeled below; hind tibiæ with short spines on the outside, and two long spurs on the inside at the tip (sec. Haliday; one apparently missing); colour metallic.

12. Notaspis. (Plate III. figs. 22, 23.)

Notaspis, Walk. Ent. Mag. ii. p. 37 (1837).

Type *N. formiciformis*, Walk. *l. c.* p. 38, from St. Vincent's.

Head large, broader than the thorax; eyes large and very prominent; antennæ 13-jointed, inserted near the mouth, subclavate, scape about one third of their length; scutellum very large and produced to a point; abdomen sessile, first joint very large; hind femora moderately swollen, with a large obtuse projection beneath.

13. Epinæus. (Plate III. figs. 24, 25.)

Type *Smicra dux*, Walk. Journ. Ent. i. p. 173 (1861), from Pará.

Head as broad as the thorax: antennæ 14-jointed, moderately thick, and slightly pubescent; scape rather long, inserted about the middle of the face, which is excavated to the front ocellus; joints 2–4 minute: abdomen with a short but distinct petiole, and gradually produced into a long pointed cone; scutellum bidentate; hind coxæ long, with a leaf-like projection above; hind femora armed beneath with rather large teeth, that at the base much larger than the others; nervures of the wings indistinct.

14. Conura, Spin. (Plate III. figs. 26, 27.)

Conura, Spin. Mag. Zool. vii. Ins. pl. clxxx. (1837).

Type *C. flavicans*, Spin., from Brazil. (Recently bred by Mr. P. N. Braine, from cocoons of *Altarus Hesperus* (?), from Cayenne.)

Antennæ inserted near the epistoma, 12-jointed, the second joint smallest, front deeply excavated; hind femora minutely denticulated below; nervures of the wings well marked.

15. Stypiura. (Plate III. figs. 28–30.)

Allied to *Conura*, but placed by Sichel in *Phasgonophora*.

Type *Chalcis conigastra*, Perty, Del. Anim. Art. p. 134, pl. xxvi. fig. 16 (1834), from the Amazons.

Antennæ 11-jointed, pubescent, moderately stout, second joint short, cup-shaped, third small, the rest of uniform thickness; scape rather short, inserted high up in the face, about opposite the middle of the eyes; sutures of the mesothorax indicated; scutellum with a bidentate projection behind; metathorax with two teeth on each side; abdomen subpetiolate, conical, the first two segments of equal length, much longer than the remainder, short; the abdomen itself smooth and shining, but produced into a rather stout stylus of equal length, and covered with shaggy hair; hind femora with one large tooth and six smaller teeth.

16. Phasgonophora. (Plate III. figs. 31–33.)

Phasgonophora, Westw. Griff. An. Kingd. xv. p. 432 (1832).

Type *P. sulcata*, Westw. *l. c.* pl. lxxvii. fig. 2, from Georgia.

Antennæ 13-jointed, unusually long and slender, and absolutely uniform in thickness throughout, inserted just below the eyes, scape long, second joint short, third and fourth very minute, these joints bare, the remainder pubescent; scutellum unarmed; metathorax with two very short teeth on each side; abdomen as in *Stypiura*, but only with short bristles, and strongly punctured towards the base; hind femora with twelve teeth, the first, fourth, and fifth large and widely separated, second and third minute, fifth to twelfth gradually decreasing in size; wings rather short.

17. Trigonura. (Plate IV. figs. 1, 2.)

Trigonura, Sich. Ann. Soc. Ent. Fr. (4) v. p. 376 (1865).

Type *Phasgonophora crassicauda*, Sich. *l. c.* p. 377, pl. x. fig. 1, from Mexico.

Sichel regards this genus as a section of *Phasgonophora*, and distinguishes it as follows:—" Abdomine latiori, ovoideo, minus vel vix compresso; segmento primo solo longissimo, reliquorum brevium simul sumtorum longitudinem æquante; cauda non compressa, ensiformi, sed depressa, latiuscula, subtriangulari."

18. ASPIRHINA. (Plate IV. figs. 3–5.)

Type *Halticella dubitator*, Walk. Trans. Ent. Soc. Lond. (3) i. p. 366 (1862), from Santarem.

Antennæ 11-jointed, inserted near the mouth, short, thick, subclavate, and extremely pilose; scape about one third of the total length; scutellum projecting behind in a long straight spine; hind femora unarmed, but fringed with short hairs beneath; abdomen pear-shaped, the first segment occupying about two fifths of its length.

Resembles *Neochalcis* and *Trichoxenia* in the peculiar structure of the scutellum.

19. PROCTOCERAS. (Plate IV. figs. 6–8.)

Type *Smicra leucotelus*, Walk. Journ. Ent. i. p. 181 (1861), from Ega.

Antennæ 13-jointed, short, rather stout, of uniform thickness, inserted nearly opposite the lower border of the eyes and clothed with fine bristles, scape and the short second and third joints nearly naked; sutures of the mesothorax obsolete; scutellum unarmed; abdomen subpetiolated, ovoid, and provided with a slender exserted ovipositor slightly longer than the abdomen itself; hind femora moderately swollen, armed below with one large and several small teeth.

I believe that *Chalcis caudatus*, Guér. Icon. R. Anim., Ins. p. 413, pl. lxvii. fig. 6 (1829–1844), from Brazil, is a second species of this genus.

20. THAUMATELIA. (Plate IV. figs. 9, 10.)

Type *Chalcis separata*, Walk. Trans. Ent. Soc. Lond. (3) i. p. 353 (1862), from Ega.

Antennæ short, 11-jointed, inserted rather below the eyes, scape of moderate length, bare, the remaining joints pilose, the second shortest, the third longest, the remainder of nearly uniform length and thickness, terminal joint conical; scutellum and metathorax unarmed; hind femora denticulated beneath; abdomen produced into a very long slender stylus, nearly twice as long as the basal part, and fringed on each side with short bristles; first joint of the abdomen nearly equal to half the length of the broad portion.

21. Epitelia. (Plate IV. figs. 11, 12.)

Type *Chalcis stylata*, Walk. Journ. Ent. i. p. 183 (1861), from Ega.

Antennæ 13-jointed, inserted just below the eyes, much stouter than in *Phasgonophora*, scape at tip and the short second and third joints bare, the rest pubescent, apical joint conical; abdomen sessile, much shorter and stouter than in *Phasgonophora*; stylus about equal in length to the remainder of the abdomen; scutellum very slightly bidentate; metathorax unarmed; hind femora and tibiæ with numerous depressed punctures, the former apparently armed with rather large teeth.

22. Megalocolus. (Plate IV. figs. 13–15.)

Type *Halticella ducator*, Walk. Trans. Ent. Soc. Lond. (3), i. p. 357 (1862).

Antennæ thick, pubescent, 12-jointed, inserted in the middle of the face, scape long, second joint short cup-shaped, third joint short, appearing like the base of a long fourth joint, the remainder of about equal length, the last conical; end of scape, second, and third joints bare, the rest pubescent; head and thorax coarsely scabrous; sutures of the mesothorax obsolete; scutellum terminating in a raised bidentate plate behind; metathorax very hairy, with two very prominent projections on each side; abdomen subpetiolate, the first segment fully half the length of the remainder; in the female it terminates in a long stylus set with bristles, and about as long again as the abdomen itself; segments of the abdomen fringed behind with short pale hairs, most visible on the sides; hind coxæ with a leaf-like projection on the upper side; hind femora swollen, regularly dentated beneath.

Several species of this very distinct group were described by Walker under *Halticella* in Trans. Ent. Soc. Lond. (3) i. (1862), but stood in the British-Museum collection under *Phasgonophora*. These are:—*H. ducator*, Walk. (Amboina); *ensator*, Walk. (=*tentator*, Walk.), Sarawak and Singapore; *properator*, Walk. (Java); *signator*, Walk. (Java); *notator*, Walk. (*motator*, err. impr.), Sarawak; and *gladiator*, Walk. (Sarawak). Several other species from similar localities described by Walker from the Saundersian collection will probably also fall into this genus.

23. Pseudochalcis. (Plate IV. fig. 16.)

Type *Halticella declarator*, Walk. Trans. Ent. Soc. Lond. (3) i. p. 360 (1862), from Ega.

Head, thorax, and scutellum covered with very large depressed punctures; antennæ inserted high up in the face, which is channelled to receive the scape; scape rather stout, longer than the third joint, second joint minute, the remainder gradually diminishing in length beyond the third, and rather long and slender (tips broken); scutellum with a short thick smooth projection behind; metathorax with two teeth on each side; femora armed below with several small teeth; "abdomen elliptical, not longer than the thorax" (Walker).

Appears to be related to the Australian genus *Trichoxenia*.

24. Trichoxenia. (Plate IV. figs. 17–20.)

Type *Halticella cineraria*, Walk. Notes Chalc. iii. p. 45 (1871); *H. subfasciata*, Walk., described on the same page, appears to be only a smaller variety with paler wings. Both insects are from South Australia.

Antennæ inserted far below the eyes and near the mouth, 12-jointed; face deeply channelled as far back as the ocelli for the insertion of the scape; scape one fourth of the length of the antennæ, dilated at the end; second joint small, third joint short, fourth longer, the remainder gradually diminishing in length, the last very small and conical; thorax scabrous, sutures ill-defined; scutellum armed behind with a short straight spine; metathorax with a short spine on each side; abdomen subsessile, very convex, the first segment covering almost half its length on the back; stylus unusually short and broad, hardly one fourth of the length of the abdomen; hind femora moderately swollen, unarmed, but with a large rounded convexity at the base, beyond which they are slightly grooved for the reception of the tibiæ; wings variegated.

25. Stomatoceras. (Plate IV. figs. 21–23.)

Type *Halticella liberator*, Walk. Trans. Ent. Soc. Lond. (3) i. p. 361 (1862), from Natal.

Antennæ 11-jointed, inserted near the mouth; scape very long, almost one third of the length of the antennæ, strongly curved, and expanded at the extremity; second joint very slender at the base, gradually thickened to the extremity, about twice as long as the third joint, which is the shortest, joint 4 as long as joint 2, the rest gradually diminishing in length; terminal joint conical, about twice as long as the preceding; joints 3–11 of similar structure, not much thickened, and clothed with fine down; front channelled to receive the scape: scutellum armed with two small raised teeth; metathorax unarmed; hind femora hairy beneath; abdomen subpetiolate, first segment nearly twice as long as the others, stylus moderately slender, about half the length of the remainder of the abdomen; wings variegated.

26. Antrocephalus. (Plate IV. figs. 24–26.)

Types *Halticella fascicornis* and *divisicornis*, Walk. Notes Chalc. iii. pp. 43 & 44 (1871), from Bombay.

Allied to *Stomatoceras*. Antennæ 12-jointed, inserted near the mouth, very long, scape nearly one third of their length, nearly straight, and more slender than the flagellum; head excavated in front as far back as the ocelli; scutellum bidentate; hind femora unarmed; abdomen subpetiolate, the first segment half its length in the male and one third in the female.

27. Euchalcis. (Plate IV. figs. 27–29.)

Euchalcis, Duf. Ann. Soc. Ent. Fr. (4) i. p. 7 (1861).

Allocera, Sich. *op. cit.* (4) v. p. 379 (1865).

Type *E. Miegii*, Duf. *l. c.* p. 8, pl. i. figs. 4–7 (1861), from Spain.

Antennæ 11-jointed, long and rather slender; scape very long, inserted near the mouth; abdomen and hind femora nearly as in *Neochalcis*.

Dufour has placed several discordant species in his genus *Euchalcis*; and it is to be regretted that his type is identical with that of *Allocera*, Sich.

28. Neochalcis. (Plate IV. figs. 30–32.)

Type *Halticella osmicida*, Saund. Trans. Ent. Soc. 1873, p. 414.

Antennæ 13-jointed, short, pubescent, scape rather short and thick, inserted opposite the lower border of the eyes, second and third joints short, last three very short; sutures of the thorax well marked; abdomen subsessile, oval in the male, conical in the female, the segments gradually diminishing in length, the first not more than half as long again as the second; hind femora with a very strong projection in the middle.

29. Hockeria. (Plate IV. figs. 33–36.)

Hockeria, Walk. Ent. Mag. ii. p. 34 (1834).

Type *Chalcis bispinosa*, Fabr. Syst. Piez. p. 166 (1804), from Europe.

Antennæ 13-jointed, inserted near the mouth, longer and more slender than in *Halticella*, and with a much longer scape; scutellum strongly bidentate; abdomen sessile, oval, and slightly pointed in the female, first segment very long, covering nearly half the abdomen; hind femora minutely denticulated, and armed with two large obtuse teeth.

30. Halticella. (Plate IV. figs. 37–40.)

Haltichella (err. impr.), Spin. Ann. Mus. xvii. p. 148 (1811).

Halticella, Walk. Ent. Mag. ii. p. 33 (1834).

Type *Chalcis pusilla*, Fabr. Mant. Ins. i. p. 272, n. 6 (1787), from Europe.

Antennæ 13-jointed, inserted near the mouth, moderately thick, scape shorter than in *Hockeria*, third joint very small; scutellum rounded; abdomen short, sessile, the first segment occupying nearly half the total length above; hind femora armed with twelve rather small teeth.

This genus appears to be intermediate between *Hockeria* and *Chalcis*. Many of the European species usually referred to *Halticella* must be removed to *Hockeria*.

31. Hybothorax.

Hybothorax, Ratz. Ichn. Forstins. i. p. 209 (1844).

Type *H. Graffii*, Ratz. *l. c.* (=*Halticella myrmeleonis*, Fairm. Bull. Soc. Ent. Fr. (5) v. p. cciv), from Europe.

Antennæ 12-jointed, inserted near the mouth; metathorax with a long projection hindwards on each side.

Further observations are much wanted on this curious genus, which is parasitic on *Myrmeleon*. The peculiar form of the metathorax might appear to indicate some affinity to *Dirrhinus*; but it is difficult to form any opinion in the absence of either specimens or a figure.

32. Hippota. (Plate IV. figs. 41–44.)

Hippota (Hal. MSS. ?), Walk. Notes Chalc. iii. p. 47 (1871).

Chirocère, Latr. Fam. Nat. p. 447 (1825).

Type *Chalcis pectinicornis*, Latr. Gen. Crust. Ins. iv. p. 26 (1809), from South Europe and Algeria.

Distinguished from all other genera of this family by the long rami of the antennæ of the male, which apparently resemble those of *Cladius* in the Tenthredinidæ. Antennæ 10-jointed; scutellum long, slightly indented at the end; hind femora unarmed; metathorax with a strong spine on each side.

33. Chalcis. (Plate IV. figs. 45, 46.)

Chalcis, Fabr. Mant. Ins. i. p. 272 (1787); Spin. Ann. Mus. xvii. p. 147 (1811); Walk. Ent. Mag. ii. p. 27 (1833).

Brachymeria, Westw. Phil. Mag. (3) i. p. 127 (1832).

Type *Vespa minuta*, Linn. Syst. Nat. i. 2, p. 952, n. 28 (1767), from Europe.

Antennæ 13-jointed, short and stout, pubescent, inserted in the middle of the face, scape moderate, third joint minute; scutellum slightly bidentate; abdomen subpetiolated, pointed in the female but not much produced, first segment about half its entire length; hind femora armed with large teeth.

Synonymic Notes.

Leucospidinæ.

Leucospis, Fabr. L. affinis, Say, Long's 2nd Exped. ii. p. 327 (1824).

Leucospis affinis *et* var. floridana, *Cress. Trans. Amer. Ent. Soc.* iv. pp. 32 & 33 (1872).

Leucospis basalis, *Westw. Germ. Mag.* i. p. 264 (1839).

Leucospis canadensis, *Walk. Journ. Ent.* i. p. 17 (1860).

Hab. North America.

Leucospis antiqua, Walk. Journ. Ent. i. p. 19 (1860).

Leucospis Gambeyi, *Maindr. Bull. Soc. Ent. Fr.* (5) viii. p. clxiv (1878).

Hab. New Caledonia.

Chalcidinæ.

Smicra, Spin. I have discussed the European species in a paper recently contributed to the 'Entomologist,' vol. xv. pp. 241–244 (1882).

Smicra abdominalis, *Walk. Journ. Ent.* i. p. 177 (1861).

Smiera ambigua, *Cress. Trans. Amer. Ent. Soc.* iv. p. 44 (1872).

Hab. Mexico.

Smicra flammula, *Cress. Trans. Amer. Ent. Soc.* iv. p. 48 (1872).

Hab. Mexico.

Judging from the description, this species appears to be allied to *S. erythrina*, Walk. (Journ. Ent. i. p. 179, 1861), but to be distinct.

Smicra pulchra, *Cress. Proc. Ent. Soc. Phil.* iv. p. 94 (1865).

Hab. Mexico; Cuba.

This insect is probably identical with *S. transitiva*, Walk. (Trans. Ent. Soc. Lond. (3) i. p. 371, 1862), as the colour of the abdomen appears to be the only difference between them.

Smicra (?) femorata, *Fabr.*

Crabro femoratus, *Fabr. Syst. Ent.* p. 375, n. 10 (1775).

Sphex punctata, *Fabr. Spec. Ins.* i. p. 446 (1781).

? Chalcis fasciata, *Oliv. Enc. Méth.* v. p. 439, n. 9 (1790).

Smiera subpunctata, *Walk. Ent. Mag.* ii. p. 25 (1834).

Smiera nigropicta, *Cress. Proc. Ent. Soc. Phil.* iv. p. 95 (1865).

Hab. West Indies; Brazil.

Smicra captiva, *Smith, Trans. Ent. Soc.* (3) i. p. 42 (1862).

Smiera adaptata, *Walk. op. cit.* (3) ii. p. 190 (1864).

Hab. Panama; Amazons.

Smicra dimidiata.

Chalcis dimidiata, *Fabr. Syst. Piez.* p. 160, n. 3 (1804).

Smiera melanoptera, *Walk. Journ. Ent.* i. p. 180 (1861).

Hab. Venezuela.

Smicra descripta *et* exhauriens, *Walk. Trans. Ent. Soc.* (3) ii. pp. 197 & 198 (1864).

Hab. Amazons.

S. exhauriens only differs from the type in having the hind tibiæ tipped with black.

Stypiura, *Kirb.* (*anteà*, p. 59). S. conigastra.

Chalcis conigastra, *Perty, Del. Anim. Art.* p. 134, pl. xxvi. fig. 16 (1834?).

Haltichella erythrotelus, *Walk. Journ. Ent.* i. p. 184 (1861).

Hab. Ega.

Megalocolus, *Kirb.* (*anteà*, p. 61). M. ensator.

Halticella ensator *et* tentator, *Walk. Trans. Ent. Soc.* (3) i. pp. 357 & 358 (1862).

Hab. Borneo; Singapore.

NEOCHALCIS, *Kirb.* (*anteà*, p. 63). N. OSMICIDA, *Saund.*

Haltichella osmicida, *Saund. Trans. Ent. Soc.* 1873, p. 414; 1882, pp. 291–295; *Waterh. Aid*, i. pl. xl. (1881).

Halticella venusta *et* vetusta, *André* (*nec Duf.*), *Ann. Soc. Ent. Fr.* (6) i. p. 340, pl. ix. fig. 2 (1881).

Hab. South Europe.

Euchalcis hematomera, Duf. Ann. Soc. Ent. Fr. (4) i. p. 9, pl. i. figs. 8–10 (1861), from Spain, is closely allied to this species, and certainly congeneric.

HOCKERIA, *Walk.* H. (?) DARGELASII.

Chalcis dargelasii, *Latr. Hist. Nat. Crust. et Ins.* xiii. p. 221 (1805).

Hockeria nigra, *Walk. Ent. Mag.* ii. p. 36 (1834).

Hab. Europe.

HOCKERIA RUFIPES.

Chalcis rufipes, *Oliv. Enc. Méth.* v. p. 440 (1790).

Cynips armata, *Panz. Faun. Germ.* Heft 74, pl. cx. (1801).

Chalcis bispinosa, *Fonsc.* (*nec Fabr.*) *Ann. Sci. Nat.* xxvi. p. 279 (1832).

Hab. Europe.

HOCKERIA (?) WALKERI.

Halticella tarsalis, *Walk.* (*nec Motsch.*) *Notes Chalc.* iii. p. 44 (1871).

Hab. Bombay.

This species is probably congeneric with *Brachymeria tarsalis*, Motsch. Bull. Mosc. xxxvi. (2) p. 38 (1863), from Ceylon; and I consequently take the present opportunity of renaming it.

HOCKERIA (?) FIGURATOR.

Halticella figurator, *Walk. Trans. Ent. Soc. Lond.* (3) i. p. 367 (1862).

Halticella nigricola, *Walk. Notes Chalc.* iii. p. 43 (1871).

Hob. Gambia.

The two descriptions appear to apply not only to the same species, but to the same specimen.

HOCKERIA (?) NYSSA, *Walk. Ent. Mag.* v. p. 474 (1837).

Hockeria proxenus, *Walk. Mon. Chalc.* ii. p. 8 (1839).

Hab. Sydney; Tasmania.

Walker has placed the types of his *H. nyssa* and *proxenus* together as sexes, which appears likely to be correct, although they are from slightly different localities.

CHALCIS, *Fabr.* C. EUPLŒÆ.

Chalcis (Brachymeria) Euplœæ, *Hope, Proc. Ent. Soc. Lond.* ii. p. vi, pl. ii. figs. 9 & 10 (1836).

Chalcis Lasus, *Walk. Ent.* i. p. 219 (1841).

Chalcis inclinator, *Walk. Trans. Ent. Soc. Lond.* (3) i. p. 355 (1862).

Chalcis obscurata, *Walk. Trans. Ent. Soc. Lond.* 1874, p. 399.

Hab. India; Ceylon; China; Japan; Java; Aru.

CHALCIS FINATOR.

Halticella finator, *Walk. Trans. Ent. Soc. Lond.* (3) i. p. 368 (1862).

Chalcis mansueta, *Walk. Notes Chalc.* iii. p. 41 (1871).

Hab. Hong Kong.

The two descriptions appear to have been made from the same specimen.

CHALCIS AMENOCLES, *Walk. List Chalc.* i. p. 84 (1846).

Chalcis polyctor, *Walk. Trans. Ent. Soc. Lond.* (3) i. p. 354 (1862).

Chalcis varipes, *Walk. Notes Chalc.* iii. p. 48 (1871).

Hab. West and South Africa. (Type from Sierra Leone.)

Chalcis polyctor, Walk. Ent. i. p. 218 (1841), which also occurs at Sierra Leone, proves to be a totally different species.

CHALCIS FLAVIPES, *Fabr.* (*nec Panz.*) *Ent. Syst.* ii. p. 197, n. 10 (1793).

Chalcis ovata, *Say, Long's 2nd Exped.* ii. p. 326 (1824).

Chalcis annulipes, *Walk. Ent. Mag.* ii. p. 29 (1834).

? Leucospis integra, *Hald. P. Acad. Phil.* ii. p. 53 (1844).

Chalcis incerta, *Cress. Proc. Ent. Soc. Phil.* iv. p. 101 (1865).

Brachymeria panamensis, *Holmgr. Eugenies Resa, Ins.* p. 437 (1858).

Hab. North and Central America; West Indies.

CHALCIS (?) VICARIA, *Walk. Journ. Ent.* i. p. 183 (1861).

♀. Chalcis eurytomoides, *Walk. Trans. Ent. Soc. Lond.* (3) ii. p. 247 (1864).

Hab. Amazons.

CHALCIS DECRETA *et* CONCITATA, *Walk. Trans. Ent. Soc.* (3) i. pp. 352 & 353 (1862).

Hab. Santarem.

The specimens described under these names appear to be sexes; but the description of *C. concitata* is very imperfect.

Descriptions of New Species.

I have not a large number of new species to describe, as comparatively few additions have been made to the British-Museum collection of Chalcididæ since Walker's publications on the family.

Leucospidinæ.

Leucospis, *Fabr.*

Leucospis tricolor, n. sp.

Exp. al. 8 lin.; long. corp. 4 lin.

Black, very closely punctured, and with very fine grey pubescence. Antennæ red, first two joints blackish. Prothorax red, with a black band in the middle, sides of meso- and metathorax bordered above with red, mesothorax with a transverse red spot on the back, a large red spot just below the fore wings, and metapleura entirely red. Abdomen black, first segment not much narrower than the second, with some indistinct red markings above, and with the sides red; near the front of the second segment is a yellow belt; and towards the tip of the abdomen are two yellow spots on each side, bordered below with red ones. Legs red; coxæ black; hind coxæ red at the tips, hind femora with a large black spot on the inside, yellow above and at the base on the outside, with an irregular black mark below the yellow upper border, and armed with six very large teeth, the last obtuse. *Hab.* South Africa.

Described from one male specimen. Parasitic on *Anthidium cordatum*, Smith, according to P. Mansel Weale.

Leucospis mysolica, n. sp.

Exp. al. 9 lin.; long. corp. 4 lin.

Black, very finely punctuated, and with fine pubescence. Head and thorax with green reflections, face clothed with golden tomentum; antennæ ferruginous, scape beneath yellow. Prothorax with a broad yellow band, dilated at the sides, and partly bordered with red; mesothorax bordered with a yellow stripe on each side, and with a transverse one in the middle; scutellum with a very broad yellow band behind; beneath the fore wings is a large yellow spot; and the metapleura are almost entirely yellow. First segment of the abdomen more than half the width of the remainder, with a very broad yellow band, slightly edged with reddish in front, and partly divided by a black line in the middle above; the rest of the abdomen with a yellow band in the middle, and with a yellow streak on each side of the ovipositor at the extremity; the ovipositor is ferruginous, shading into blackish at the extremity, and recurved to much less than half the length of the abdomen. Legs yellow, shading into ferruginous; four front coxæ and femora mostly blackish; hind legs ferruginous above and within, and mostly yellow on the outside; hind femora with a comparatively small black band on the outside, and with one large and about seven small teeth. Wings smoky hyaline, very iridescent. *Hab.* Mysol.

Described from one female example, collected by A. R. Wallace.

LEUCOSPIS TOMENTOSA, n. sp.

Exp. al. 9½ lin.; long. corp. 4½ lin.

Black, closely punctured, with short greyish pubescence. Vertex and thorax tinged with metallic green; face reddish, covered with silvery tomentum. Antennæ dark brown above, reddish below, the scape inclining to yellow. Metathorax edged behind with a conspicuous yellowish-white tuft of hair on each side. Abdomen not petiolated, of equal breadth throughout. Under surface of the body mahogany-brown. Hind femora narrowly bordered with yellow above and below, with one large and about nine small teeth; hind coxæ bordered with metallic green above and below; tip of front femora in one specimen with a short yellow line beneath. Ovipositor reddish, recurved to the base of the scutellum. Wings hyaline, clouded along the costa and at the tips. *Hab.* St. Thomas; Tapajos, Amazons.

Described from three female specimens, which stood in the British-Museum collection as *Metallopsis cayennensis*, but are apparently quite distinct from that species.

CHALCIDINÆ.

SMICRA, *Fabr.*

SMICRA RUFIPES, n. sp.

Exp. al. 4½ lin.; long. corp. 3 lin.

Head and body entirely black, except a small spot beneath each antenna and the tips of the mandibles, which are reddish. Antennæ long, subclavate, apparently 12-jointed, the fourth joint longest; thorax very coarsely but evenly punctured; tegulæ reddish; petiole stout, reddish at the extremity, nearly as long as the rest of the abdomen, which is smooth and shining; legs red, hind coxæ black, hind femora with numerous small blackish teeth; tibiæ rather darker than the femora. Wings iridescent hyaline, with piceous costal nervure. *Hab.* Georgia.

This species was mixed with *S. sispes* in the British-Museum collection; but its smaller size and unicolorous femora will separate it at once.

Smicra igneoides, n. sp.

Exp. al. 5 lin.; long. corp. 3½ lin.

Warm yellowish ferruginous, finely punctured. Antennæ 13-jointed(?), black except the scape beneath, scape very long; sutures of the thorax, a longitudinal stripe on the mesothorax and scutellum, two oblique stripes on the sutures of the pleuræ, the hindermost most distinct, a longitudinal dash on the outside of the hind coxæ, and the extreme tip of the abdomen black; petiole short, not one fourth of the length of the abdomen, which is smooth and shining, and has a rather indistinct yellow stripe towards the base; teeth of the hind femora exceedingly minute. Wings hyaline, clouded towards the base. *Hab.* United States.

Close to *S. ignea*, Cress. Proc. Ent. Soc. Phil. iv. p. 92 (1865), but may be distinguished at once by the unicolorous metathorax. This species was confounded with *S. fulvescens*, Walk. Ent. Mag. ii. p. 25 (1834), in the British-Museum collection.

Smicra foveata, n. sp.

? ? Smiera contacta, *Walk. Trans. Ent. Soc. Lond.* (3) ii. p. 184 (1864).

Exp. al. 5 lin.; long. corp. 2 lin.

Deep orange, including the face and under surface of the scape of the antennæ; antennæ otherwise brown above, reddish beneath; antennal grooves edged with black; ocelli black; occiput black; prothorax with a black spot in the middle in front; mesothorax edged before and behind with black (the front stripe dentated behind), and with three longitudinal stripes, those on the side lobes incomplete behind; scutellum wider than broad, marked with a black isosceles triangle, and with two widely separated teeth behind; petiole moderately stout, about half the length of the abdomen, which is marked with transverse reddish stripes, shading into blackish on the back. Hind legs, tips of coxæ and trochanters black; femora with a large black spot below, near the base, visible on both sides, a spot on each side above, near the middle, that on the outside narrower than that on the inside;

the tip and the base of the tibiæ are also black, armed below with four large black teeth, the first at the base, and the last two close together. Wings clear hyaline, with brown costal nervure. *Hab.* Amazons.

This species stood in the British-Museum collection as *S. contacta*, Walk.; but it differs too much from his description to allow of his name being retained. He describes the abdomen as "mostly black," and the pectus with a black line on each side.

Smicra pera, n. sp.

Exp. al. 4 lin.; long. corp. 2 lin.

Yellow; antennæ black, with the scape beneath and the extreme tip reddish; prothorax with an oval spot on each of the side lobes, and bordered behind with black (central markings, if any, obliterated by the pin); pectus with a black spot on each side; scutellum with a bowl-shaped spot near the extremity, which projects a triangle forwards; petiole short; abdomen with five transverse reddish stripes; tips of hind coxæ, trochanters, and base and tips of tibiæ black; femora with a reddish-brown spot on the outside, and armed below with numerous minute teeth. Wings hyaline. *Hab.* Brazil.

Smicra incerta, n. sp.

Smiera certa ♀ ?, *Walk. Trans. Ent. Soc. Lond.* (3) ii. p. 183 (1864).

Exp. al. 8 lin.; long. corp. 3 lin.

Black. Antennæ reddish beneath; scape long, yellowish beneath; a large pale spot on each side of the face just below the antennæ. Prothorax edged behind with yellowish on each side, interrupted on each side of a spot in the middle of the hind border; mesothorax granulated; tegulæ, sides of hind border of mesothorax, a spot on the mesopleura, and hind border of scutellum (which is bidentate) yellowish. Petiole short, black. Abdomen with strong ferruginous reflections; but its basal third, which is bounded behind by a yellowish stripe, is lighter than the remainder; near the tip is another yellowish stripe. Four front legs black; tarsi, a line on the outside of the front tibiæ, and at the base of the middle tibiæ pale yellow, or whitish; hind coxæ with a yellowish stripe beneath on the basal half; femora with a yellow stripe on each side, broadest on the inside, and armed below with six teeth, the second small; tips of femora on the inside and base of tarsi ferruginous. Wings yellowish hyaline. *Hab.* Amazons.

Walker regarded this insect as probably the female of his *S. certa*; but it differs considerably from his type, which appears to be likewise a female.

SMICRA DECIPIENS, n. sp.

Exp. al. 6 lin.; long. corp. $3\frac{1}{2}$ lin.

Black; scape beneath and inner orbits broadly yellow; prothorax edged behind with yellow, the stripe emitting a slender branch obliquely forward on each side; mesothorax somewhat more coarsely punctured than in *S. discolor*, the upper part of the middle and side lobes edged with yellow; scutellum with a yellow band in front; and there is a yellow spot on the metathorax on each side of this; the scutellum is bidentate, and bordered with yellow behind and at the sides more narrowly than in *discolor*, but continuously; petiole very short and stout, yellow; abdomen yellow, banded with black in the middle, the black portion enclosing a yellow line on each side near the extremity. Four front legs yellowish, femora black nearly to the extremity, and tibiæ with a black line on the outer side. Hind coxæ yellow with a black triangular spot at the base beneath, trochanters black, femora black with a yellowish tawny mark at the base beneath, and a stripe of the same colour near the tip extending almost all round, armed below with two small and five very large teeth; tibiæ black, with a yellow band near the middle; tarsi yellow, the last joint black. Wings brownish hyaline, with blackish nervures. *Hab.* Villa Nova, Amazons.

Closely resembles *S. discolor*, Walk. Journ. Ent. i. p. 180 (1861).

SMICRA BURMEISTERI, n. sp.

Exp. al. 5 lin.; long. corp. 3 lin.

Dull yellow; antennæ brown, clothed with dense greyish pile, scape yellow beneath, antennal fossa black; mandibles tipped with black; occiput and adjacent portion of prothorax black; central lobe of mesothorax either wholly black or broadly bordered with black before and behind and with a central black line, lateral lobes with a thick black stripe; hinder and lateral sutures of the mesothorax and a band behind and below the scutellum black; petiole reddish above and black on the sides, rather more than half the length of the remainder of the abdomen, which is oval, yellow at the base, and black (banded with yellow on the upper side) beyond; legs yellow, hind legs:—

coxæ rather longer than the petiole, black beneath, and with a reddish line on the outside; trochanters black; femora with a black spot at the tip, hairy and probably serrated beneath; tibiæ black, with a yellow stripe on the inside; tarsi yellow. Wings hyaline. *Hab.* Argentine Republic. Presented by Dr. Burmeister.

PHASGONOPHORA, *Westw.*

PHASGONOPHORA? BATESII, n. sp.

Exp. al. $4\frac{1}{2}$ lin.; long. corp. 3 lin.

Head, pectus, and apical third of the abdomen black; thorax red, very coarsely punctured; scutellum slightly pointed behind; base of abdomen dark red; front knees, tibiæ, and tarsi, middle knees and tarsi, and the tips of the hind femora and tibiæ whitish; hind tarsi inclining to yellowish; hind femora black outside and reddish inside, armed below with about six teeth. Wings hyaline, with brown costal nervure. *Hab.* Santarem.

THAUMAPUS, *Kirb.* (anteà, p. 56.)

THAUMAPUS WALKERI, n. sp.

Smicra luteipennis (♂)? *Walk. Journ. Ent.* i. p. 173 (1861).

Exp. al. 11 lin.; long. corp. 4 lin.

Tawny, pale greyish yellow beneath, occiput and vertex entirely black as far as the antennæ, which are also black, except the scape beneath, which is rather short; mesothorax with a square spot at the extremity, from which runs a black line on the front half of the scutellum; scutellum armed behind with two short sharp teeth projecting upwards; back of mesothorax with a conspicuous rectangular prominence on each side; metathorax with a spine on each side of the petiole, which is as long as the abdomen, and marked with a black line above; abdomen short and stout, tip black; base of ovipositor black, and a broad black band above, not extending to the base; hind coxæ with a black line on the outside; femora armed below with numerous minute black teeth; apical half of hind femora black on the inside. Wings yellowish, tips clouded. *Hab.* St. Paulo, Upper Amazons.

HOCKERIA, *Walk.*

HOCKERIA (?) CANARIENSIS, n. sp.

Exp. al. $2\frac{1}{2}$ lin.; long. corp. 2 lin.

Black; fore part of the body coarsely, and abdomen finely punctured. Antennæ 11-jointed, inserted near the mouth, very long and slender; scape nearly one third of total length, attenuated beyond the middle and thickened towards the base and also immediately at the tip; second joint also thickened at the tip; scape and second joint reddish at the tips, otherwise black; the remaining joints black, and of equal width, the divisions very indistinct. Legs reddish yellow; femora black, except at the tip; middle tibiæ blackish between one fourth of the distance from the base and the middle, and hind tibiæ blackish at the base and beneath. Wings strongly smoky in the middle; the costal nervure about half the length of the wing, brown, darkening at the extremity, where it terminates in a thick oval club; scutellum unarmed. Abdomen sparingly clothed with white hairs beneath; hind femora apparently unarmed and carinated beneath. *Hab.* Canary Islands. Collected by the late T. V. Wollaston.

CHALCIS, *Fabr.*

CHALCIS CALLIPUS, n. sp.

Exp. al. $4\frac{1}{2}$ lin.; long. corp. $2\frac{3}{4}$ lin.

Black, clothed with a short grey pubescence, antennal grooves reddish on the inside; thorax and scutellum coarsely punctured, the sutures well defined; prothorax about twice as broad as long; scutellum bituberculate; metathorax rugose, armed with two short spines on each side; tegulæ and the space immediately at the insertion of each wing ivory-white; abdomen with the first two segments smooth and shining above, the second and following with greyish down on the sides; under surface of abdomen reddish; four front femora black, broadly white at the tips, tibiæ white, more or less black in the middle, and all the tarsi whitish shading into fawn-colour; hind coxæ, trochanters, and femora entirely red, except a white spot at the extremity of the latter on the outside; hind femora armed below with a series of small teeth; hind tibiæ black, with the tip white, and an oblong white spot near the base. Wings hyaline, with yellowish costal nervure and blackish stigma. *Hab.* Japan.

Closely allied to the European *C. Fonscolombei*, Duf. (*podogrica*, Rossi, nec Fabr.); but in that species the hind coxæ are black at the base.

Chalcis Hearseyi, n. sp.

Exp. al. 5 lin.; long. corp. 2 lin.

Black, finely and closely punctured; face &c. clothed with silvery pubescence; scutellum unarmed; legs lemon-yellow, four front femora black nearly to the tip; hind coxæ and femora black, the latter yellow on both sides at the extreme tip and finely denticulated beneath; hind tibiæ black for at least two thirds of their length; claws black. Wings clear hyaline, with brown costal nervure. *Hab.* Barrackpore, India (collected by Sir J. Hearsey).

Closely allied to the widely ranging *C. Euplœæ*, Hope; but in that species the hind tibiæ are black at the base only.

Chalcis atrata, n. sp.

Exp. al. 5 lin.; long. corp. 3 lin.

Black, covered with a hoary pile, which is much more conspicuous than usual except on the first segment of the abdomen, even covering the hind femora; a reddish dot below the scape of each antenna; legs black; knees, tips of tibiæ, and tarsi testaceous; hind femora armed with about eight minute teeth. Wings hyaline, with brown costal nervure. *Hab.* Queensland.

Chalcis Cowani, n. sp.

Exp. al. $4\frac{1}{2}$ lin.; long. corp. 2 lin.

Black, head and thorax very strongly rugose-punctate; abdomen smooth and shining; tegulæ, knees, tibiæ and tarsi all pale whitish yellow; hind femora armed with about seven large obtuse teeth, set widely apart; inside of hind tibiæ black. Wings hyaline, with brown nervures; costal nervure much thickened at the junction of the subcostal; stigma boot-shaped. *Hab.* Madagascar (Antananarivo).

Reared from pupæ of *Papilio Demoleus* and of a species of *Nephele* (Rev. W. Deans Cowan).

Chalcis Wollastoni, n. sp.

Exp. al. 4 lin.; long. corp. $1\frac{1}{2}$ lin.

Black; head, thorax, and scutellum covered with large punctures; scutellum slightly bidentate; front legs mostly yellow, four front femora black at the base, front tibiæ with a long black spot on the outside, and middle and hind tibiæ black except at base and tip; hind femora black, except at the tip, and armed below with a series of strong but rather short teeth; wings subhyaline, with brownish yellow nervures. *Hab.* Canary Islands. Collected by the late Mr. T. V. Wollaston.

DESCRIPTION OF THE PLATES.

The series of figures exhibit structural details of genera of Chalcidinæ.

Plate III.

Figs. 1–3. *Smicra sispes*, Linn. 1, antenna; 2, hind leg; 3, middle leg.
4, 5. *Spilochalcis xanthostigma*, Dalm. 4, middle leg; 5, hind leg.
6, 7. *Epitranus fulvescens*, Walk. 6, antenna; 7, hind leg.
8, 9. *Anacryptus impulsator*, Walk. 8, antenna; 9, hind leg.
10, 11. *Arretocera albipennis*, Walk. 10, antenna; 11, hind leg.
12–14. *Thaumapus decora*, Walk. 12, antenna; 13, hind leg; 14, wing.
15–17. *Dirrhinus excavatus*, Klug (Dalman ?). 15, antenna; 16, hind leg; 17, outline of body.
18. *Eniaca hesperidum*, Rossi. 18, antenna.
19. *Axima spinifrons*, Walk. 19, outline of body.
20, 21. *Agamerion gelo*, Walk. 20, antenna; 21, hind leg.
22, 23. *Notaspis formiciformis*, Walk. 22, antenna; 23, hind leg.
24, 25. *Epinæus dux*, Walk. 24, antenna; 25, outline of winged insect.
26, 27. *Conura flavicans*, Spin. 26, abdomen; 27, hind leg.
28–30. *Stypiura conigastra*, Perty. 28, outline of body; 29, hind leg; 30, scutellum.
31–33. *Phasgonophora sulcata*, Westw. 31, antenna; 32, hind leg; 33, abdomen.

Plate IV.

Figs. 1, 2. *Trigonura crassicauda*, Spin. 1, abdomen; 2, apex of abdomen enlarged (after Spinola).
3–5. *Aspirhina dubitator*, Walk. 3, antenna; 4, hind leg; 5, scutellum and abdomen.
6–8. *Proctoceras leucotelus*, Walk. 6, antenna; 7, hind leg; 8, abdomen.
9, 10. *Thaumatelia separata*, Walk. 9, antenna; 10, abdomen.
11, 12. *Epitelia stylata*, Walk. 11, antenna; 12, abdomen.
13–15. *Megalocolus ducator*, Walk. 13, antenna; 14, hind leg; 15, outline of body.
16. *Pseudochalcis declarator*, Walk. 16, scutellum.
17–20. *Trichoxenia cineraria*, Walk. 17, antenna; 18, abdomen; 19, 20, scutellum.
21–23. *Stomatoceras liberator*, Walk. 21, antenna; 22, hind leg; 23, abdomen.
24–26. *Antrocephalus fascicornis*, Walk. 24, antenna; 25, hind leg; 26, abdomen.
27–29. *Euchalcis Miegii*, Duf. 27 antenna; 28, hind leg; 29, abdomen (after Dufour).
30–32. *Neochalcis osmicida*, Saund. 30, antenna; 31, hind leg; 32, abdomen.
33–36. *Hockeria bispinosa*, Fabr. 33, antenna; 34, hind leg; 35, abdomen; 36, scutellum.

Figs. 37–40. *Halticella pusilla*, Fabr. 37, antenna; 38, hind leg; 39, abdomen; 40, scutellum.

41–44. *Hippota pectinicornis*, Latr. 41, antenna (♂); 42, antenna (♀) (after Lucas); 43, hind leg; 44, scutellum (from the type of *Chalcis alexion*, Walk., = *H. pectinicornis* ♀).

45, 46. *Chalcis minuta*, Linn. 45, antenna; 46, hind leg.

No details are figured of the genera *Chalcitella*, Westw., and *Hybothorax*, Ratz.

Description of *Ligula Mansoni*, a new Human Cestode. By Prof. T. Spencer Cobbold, M.D., F.R.S., F.L.S.

[Read December 21, 1882.]

On the 29th of June, 1882, I received from Dr. Patrick Manson, of Amoy, a small bottle containing numerous flattened shreds bearing but slight resemblance to ordinary tapeworms. They were preserved in spirit. The donor, who had the advantage of seeing them in the fresh state, recognized their parasitic character, but entertained a doubt as to their cestode nature. I have often received flattened fibrinous clots resembling parasites; but from the first I conjectured that we had here to deal with immature Ligules. The bottle bore a label with a brief notice to the following effect:—"Tape-like parasites from subperitoneal fascia of Tchai, [who] died, after operation for lympho-elephantoid scrotum, of dysentery, and ulcerated stricture of the œsophagus." The date of this "find" was Sept. 21, 1881; but it was not until the 26th of September of the current year that I found leisure to renew my examination of the specimens. In the interval Dr. Manson furnished me with full particulars of the patient. The MS. was forwarded to the Editor of the 'Lancet,' and the case was published on the 14th of October last. In the account of the *post mortem* there given, Dr. Manson more explicitly states that "a number of parasites, twelve in all, were found lying in the subperitoneal fascia, about the iliac fossæ and behind the kidneys. A single parasite was found lying free in the right pleural cavity. Some of these parasites were coiled up in knots, and others lay extended. On being drawn from under the peritoneum, they exhibited languid movements like those of tapeworm." Further on he states that the worms had a "dead white" appearance and "moved distinctly when taken out of the body."

When I removed the parasites from the bottle, they came away in a lump; and it took much time to unravel them. This was done under spirit. I then found that there were twelve specimens, of which seven were tolerably perfect, though unnaturally twisted and otherwise distorted. All were evidently much contracted by the action of the spirit. Thus, of the perfect specimens, the shortest measured $1\frac{2}{10}$, and the longest only $3\frac{1}{4}$ inches. In most examples the worm was broader at the head than elsewhere, measuring in that situation precisely $\frac{1}{10}$ of an inch. In one specimen, however, the lower third of the strobile was actually broader than the head—that is to say, it measured exactly $\frac{3}{10}$ of an inch transversely. These measurements were made with great care; but I was not prepared to find that Dr. Manson's examinations had yielded such marked differences of size. In a recent communication he tells me that in the living state the parasites were from twelve to fourteen inches long, $\frac{1}{8}$ of an inch broad, and $\frac{1}{64}$ of an inch in thickness.

With a pocket lens I could everywhere discern transverse rugæ. These, however, were not only more conspicuous in the region of the head, but at the same time more regularly arranged. In several specimens a distinct central longitudinal line was observed, forming a ventral groove which extended from head to tail. In these specimens the dorsal surface also showed indistinct longitudinal lines, apparently due only to a backward folding of the lateral margins of the strobile. Many other grooves, markings, and prominences could be seen with objective glasses of low power; but there was a want of uniformity about them. Even with higher powers I failed to obtain any certain evidence of either reproductive pores without or sexual organs within the strobile. After soaking a specimen for 24 hours in glycerine, the calcareous corpuscles were as distinctly seen as they must have been witnessed by Dr. Manson in the fresh state, judging from a pen-and-ink sketch with which I have been furnished. They are oval, flat bodies, having an average diameter of about $\frac{1}{1000}$ of an inch. After enclosing a portion of the strobile in a tube of melted wax, and allowing it to harden, very thin sections were obtained and examined; but none of these yielded any trace of a testis, of an ovarium, or of an ovum.

Thus it became clear that in *Ligula Mansoni* (for it had been so provisionally named in the 'Lancet') we had to deal with a sexually immature parasite, comparable to the ordinary *Ligula simplicissima* frequently found in the abdominal cavity of fresh-water fishes. Not only so; further comparison with other hitherto described Ligules showed that it came nearer to *L. simplicissima* than to any other species. Without asserting positively that it may not be a variety of that form, I think we are justified in regarding the human worm as the immature representative of a totally distinct species. The unique character of its habitat, associated with certain differences of form, seem to warrant this conclusion.

LIGULA MANSONI, sp. nov.

Strobile flat, with irregular transverse folds, broader in front than behind; head distinct, with regularly arranged rugæ, produced anteriorly to form a papilla, retracted at the point to form a deep sucker-like cup; ventral surface marked by a distinct longitudinal groove in the middle line; reproductive pores wanting.

Length (in the living state) 12 to 14 inches; breadth $\frac{1}{8}$ of an inch; thickness $\frac{1}{64}$ of an inch.

Hab. Cavity of the pleura and subserous aponeurotic membranes of the abdomen of man.

The more one reflects upon what is known of the life-history of the Ligules the more one becomes puzzled to account for this invasion of the human body. The occurrence may fairly be pronounced unique. It is true, indeed, that one other instance has been placed on record where a Ligule was said to have escaped from the human intestine. I allude to the case mentioned by Rudolphi, and already quoted by Dr. Duchamp in his beautiful memoir published in 1876. Parasitism by Ligules in other creatures than birds and fishes is of such rare occurrence that M. Duchamp is inclined to regard such phenomena as accidental. He then refers to the (as supposed by him) only two instances hitherto placed on record, namely the human case and the instance where one was found in a seal, and remarks that even these "are far from being quite certain." What he says respecting the human case is well worth quoting. This instance, he says, "reported by Rudolphi from an observation about the year 1763, concerns a young girl, 25 years of age, [*sic*] who along with *Tænia* appears to have passed fragments of a ligule. Even before the publication of the 'Histoire des Entozoaires,' Bloch had shown how difficult it was to admit the introduction of a living ligule with food, by the experiments undertaken to reply to Rosen of Rosenstein, who supposed that the thing was quite possible, and who had himself seen living ligules in cooked fish (*poissons cuits*)."

The quotation by M. Duchamp is made from Rudolphi's

'Natural History of the Entozoa,' published in 1808; but in my copy of Rudolphi's 'Synopsis,' published in 1819, I find no allusion to the human case. I think indeed, with M. Duchamp that the woman's ligule was not a genuine instance of parasitism by that genus; but from what I have seen of monstrous developments of tapeworms in the human body, I am of opinion that the supposed ligule was a portion of the strobile of a malformed *Tænia mediocanellata*, destitute of segmentation. Prof. Aitken, of Netley, once sent me a complete tapeworm of this kind in which there were neither distinct proglottides nor any true head. The worm might easily have been mistaken for a new kind of ligule.

Whatever interpretation is put upon the case above mentioned, there can be no doubt that in *Ligula Mansoni* we have a genuine cestode parasite, infesting the tissues of man. Its source is difficult to explain; for whilst, with Rosen, we have seen ligules in the flesh of fishes, it is by no means clear that the ingestion of fish-ligules could produce parasitism in man. Indeed it may safely be said that ligulosis could not be produced in this way. If it could, such a disorder would probably not be of rare occurrence. In Italy, it is well known that the sexually immature tapeworms of fishes are relished by the people as edible delicacies. In my copy of Rudolphi, his words are "Ligulæ in pisciculi Cyprino Barbo affinis abdomine obviæ Italis nomine *macaroni piatti* edules et in deliciis sunt." This passage has been freely quoted by Diesing and other helminthologists, including M. Duchamp. It is also worthy of remark that the *Ligula edulis* of Briganti is regarded by M. Duchamp, as it was also by Diesing, as a synonym of *L. simplicissima*.

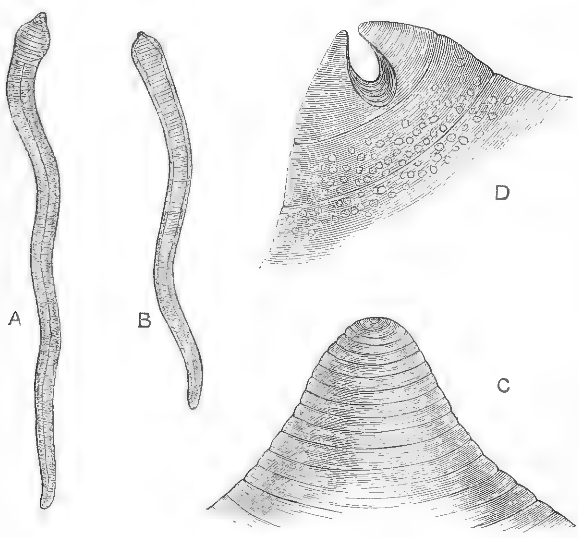
I should be sorry to have misunderstood M. Duchamp; but from his remarks (at p. 34 of his memoir) I am led to infer that the fact of parasitism by ligules having occurred in other mammals than seals has been overlooked by him. He says:—"Concerning the parasitism beyond [or outside] that of birds, one cannot but admit it as an accidental coincidence. Facts of this kind are moreover extremely rare; we have not encountered more than two; and, again, they are far from being quite certain." These words by themelves are explicit enough; and after recording the human instance already quoted by me, he refers to the seal's ligule, which, as he clearly points out, was subsequently shown to be the closely allied Cestode called *Schistocephalus dimorphus*. The perusal of this passage has puzzled me all along; for

M. Duchamp quotes freely, and with uniform accuracy, from Diesing's writings (both from the 'Systema' and his various 'Revisionen'), and yet it is Diesing who refers to *Ligula reptans* as occurring in Reptiles, Amphibia, Aves, and Mammalia. In connexion with the data supplied by Manson's "find," it is interesting to observe that in all the birds and quadrupeds proper, and also in the bats and marmosets in which a ligule has been found, the parasite was always either situated within the muscles or in subcutaneous follicles. This, at least, shows a similarity of habit; and if *Ligula reptans* were possessed of a longitudinal groove and were not furnished with cephalic pits, one might suppose it to be identical with *L. Mansoni*. Again, the external characters rather forbid our connecting the human ligule with *Ligula nodosa* of the trout, though such identity, if proven, might help to explain the origin of *L. Mansoni*.

As already pointed out in my larger treatise, the observations of M. Duchamp, taken in connexion with the embryological studies of the late Dr. Bertolus, render it extremely probable that the trout's ligule is the sexually immature state of the great broad tapeworm of man. If this genetic relation should be established by further researches (as in all probability it will be), it is possible that the proscoleces or six-hooked embryos of *Bothriocephalus latus* might, in place of passing through the ordinary intermediate piscine host, develop as immature ligules within the human body. We know that phenomena precisely analogous to this do actually obtain in the case of *Tænia solium*, the proscoleces developing into scoleces or Cysticerci within the human territory instead of passing into the flesh of swine. In this case the ultimate host becomes also (for the subsequent generation) the intermediary bearer; an act of cannibalism would certainly bring about the completion of the genetic cycle.

In this explanation I cannot take into account the possibility of any Cestode dimorphism such as M. Mégnin argues for so warmly in other cases. I do not believe that it has been proved in any instance of tapeworm life. Here, I think, we are only entitled to conclude that the Chinese host became victimized by his having swallowed the six-hooked embryos of an adult Cestode of some kind or other. In all likelihood the worm was either a *Ligula* or a *Bothriocephalus*. In any case the phenomenon was probably an instance of "straying." If so, we ought to be able to identify *Ligula Mansoni* either with some hitherto known sexually immature ligule or with a form yet to be discovered.

From the investigations of Knoch, of Leuckart, and of Drs. Bertolus and Duchamp, we know that the six-hooked proscoleces of these worms are developed within a ciliated sphere. Thus, Dr. Bertolus proposed that we should call the proscolex the embryo proper, employing his new term *embryophore* to designate the free-swimming, ciliated, nurse-like embryo. It is certain that ponds and streams frequented by water-birds infested with ligules must contain multitudes of these ciliated embryos, and thus (with the explanations already offered as to the genetic relations of the Bothriocephali) we have not far to seek for the cause of infection of dogs and men by the broad tapeworm. In like manner the drinking of any open waters that happen to contain these ciliated larvæ might also bring about infection by ligules. In this way I think we may account not only for the occasional introduction of *Ligula reptans* into the muscles of various mammals, birds, and reptiles, but also for the solitary instance in which a Chinese water-drinker shared with these animals the privilege of harbouring a similar cestode guest.



Explanation of Figures.—Two examples of *Ligula Mansoni*. A, as seen from before; B, from behind (slightly enlarged from spirit specimens); C, papilla of the head (× 15 diam.); D, end of the papilla, showing cephalic pit and calcareous corpuscles. The last figure reduced from a drawing by Dr. Manson (magnified about 80 diam.).

Observations on the Marine Fauna off the East Coast of Scotland.

By Francis Day, F.L.S.

[Read December 21, 1882.]

During the last few years considerable interest has been felt, both by naturalists and fishermen, in the fact that the herring-fisheries along the east coast of Scotland have been carried on much further from the shore than was formerly the case, and this has necessitated the employment of larger and better-found fishing crafts, which, however, in boisterous weather find it difficult or impossible to enter with safety into the existing harbours.

The local fishermen having expressed considerable doubts respecting the accuracy of the charts of the coast, Sir George Balfour, K.C.B., M.P., drew the attention of the Board of Trade to the subject; and H.M. surveying vessel 'Triton' was directed to be sent in July 1882, under Staff-Commander Tizard, to survey off Aberdeenshire, Kincardine, and the north part of Forfar.

Having been invited to join the survey party, I took the opportunity of inquiring locally into the opinion of the fishermen and others, the reason why the herring-fisheries were being carried on further out to sea, and also if the inshore ones were less prolific than they used to be. For it has appeared to me rather remarkable that some who will not admit the possibility of the inshore fisheries being less prolific than formerly, pointing out the generally increased supply from the line fishermen, do not deny that the inshore herring-fisheries are less prolific than they were a few years since, although an augmented herring supply reaches the market.

In the following brief notes I have not thought it necessary to enter fully into points which have been discussed elsewhere, but confined myself as much as possible to such as are still subjects of debate. Questions of fisheries I have more fully detailed, and drawn attention to some subjects on which, I would venture to submit, further information is very desirable.

The Herring-Fishery.—Concerning the investigations of the Commissioners on the "Scotch Herring-Fishery," published in 1878, I have a few observations to make. It is remarked that the herring-fishery on the coast of Scotland as a whole has increased and is increasing, while any further legislation respecting it is deprecated, and that "neither government encouragement nor restrictive legislation has had much effect on its herring fishery. Its progress is marked by constant fluctuations from year to year, but is on the whole a record of continually increasing prosperity from 1809 to the present time." "The prosperity of the Scotch herring fishery is entirely due to the extraordinary development of the fisheries on the Aberdeenshire and Forfarshire coast;" and "if the takes between Fraserburgh and Montrose be deducted, the condition of the other fisheries will be found to be much less satisfactory." "However little effect the enormous mass of netting may have on the stock of herrings, we think it reasonable to conclude that the fish may be scared by these means and deterred or intercepted from entering the narrow waters, and firths, and lochs of Scotland" (p. xxiii). During the last few years, however, the fishing has been conducted further and further out to sea, and the fisheries of the Firths themselves have either decreased or become neglected. Twenty years since (about 1858)* a boat carried twenty-four nets made of hemp, each net forty yards long, with twenty-eight or twenty-nine meshes to the yard, and ten to twelve score deep, or nine hundred and sixty yards of netting, having a catching surface of 3000 square yards; while in 1878, a boat carried fifty to sixty nets made of cotton, each net sixty yards long, with thirty-five meshes to the yard, and eighteen score meshes deep, or 3300 yards of netting having a catching surface of 33,000 square yards.

From the report we may conclude:—(1) that the amount of netting employed has vastly increased of late years, while the size of the mesh has likewise greatly diminished; (2) that generally in Scotland herrings have forsaken the inshore fishing-grounds and gone further out to sea; (3) that it does not appear improbable that increased netting or such being carried on in too indiscriminate a manner may have had something to do with the fish retiring to deeper water; (4) that in the Moray Firth, sprat-fishing increased in 1868, when restrictive enactments were repealed, while the commencement of the decrease of herrings began the same year.

The migrations of the herring have given rise to many speculations, and is a subject that still requires much elucidation.

* Probably five or ten years prior to the date assigned.

Some suppose that this fish is not, strictly speaking, migratory—that is, that it does not travel comparatively far from the locality in which it was hatched, reared, and came to maturity, but simply changes from shallow to deep water, in accordance with temperature and the supply of food—one proof advanced being that certain definite varieties are present in certain waters. Where they conceal themselves is certainly remarkable. Thus along the Devonshire and south-west coast of England, Mr. Dunn observes that should a gale spring up numbers are taken in nets purposely anchored parallel to the shore, while they are meshed on the land side, and this in localities which had been unsuccessfully swept by seines and nets a very short time previously.

That herrings, in common with other species of the herring family, will occasionally disappear from one locality, sometimes reappearing in another, is well known. I have observed it as occurring among the oil-sardines of India (*Clupea longiceps*); and this has taken place in years when the fishing was very little prosecuted. From 1690 to 1709 a very extensive herring fishery existed at Cromarty; about the latter year an immense shoal was driven ashore near the town; the remainder left the vicinity in a single night; and for upwards of half a century no shoals reappeared.

The two main objects of migration would appear to be for the purpose of seeking some locality where spawn may be safely deposited and the species continued, or else a search for food in order to maintain the growth and existence of the individual. But it would seem that fish may seek new ground when that they usually reside on has become unsuited to them from any cause, as absence of food or even their constant capture by incessant netting. If having selected waters further from the shore than formerly, the spawn were deposited and bred there, it does not seem unreasonable to suppose that the progeny would locate themselves where they were reared. In time, perhaps, this new location may be found unsuited, and the shoal may return to the spot they first inhabited, and where possibly a more abundant supply of surface-food may exist.

At Wick, upon the north-east coast of Scotland, the largest race usually arrives with the new year, remaining until about March, and then disappears. The next herrings come in May or June in the shape of a few small ones of little value as food, although good as bait for other fishes, and which appear to be the forerunners of the summer fish, as they grow better, larger, and fatter as the season advances, until they are in perfection about July and August, spawning about the end of the latter month or early in September, after which they disappear until the succeeding January (Reid, MSS.). If we turn to the Herring Fishery Report of 1878, we are informed that "it is a very remarkable circumstance that the yield of the fishery at Wick began to decline at the very period at which the produce of the Aberdeenshire fisheries began to increase" (lxiii). Here it would be as well to consider whether any change was during this period instituted in the working of the Wick fisheries which might account for the migration of the fish elsewhere. Mitchell, who wrote in 1864, remarked on the herring appearing off Wick, the Moray Firth, and Aberdeenshire in June; but he observed they are at first so small that the nets cannot catch them *, but they begin to be of sufficient size in July (at this time the mesh of the nets was not less than one inch between knot and knot) †.

In the fourteen years from 1849 to 1862, one thousand and three boats were annually employed in fishing at Wick, with an average catch per boat of one hundred and thirty-three barrels. During that period no winter fishing was carried on: it now commenced, and in the fourteen years from 1863 to 1876 eight hundred and eighty-five boats were annually similarly employed, and the average catch per boat was one hundred and eight barrels. The witnesses condemned the decrease which had taken place in the size of the mesh of the nets, and in the change of shooting nets before sunset having become more common; whilst it was noticed that the Wick Chamber of Commerce for some years gave a premium to the fisherman who

* In 1809 an Act of Parliament was passed regulating the mesh of the herring-net at not less than one inch between knot and knot; England and France concluded a convention with these provisions in 1839, which was abrogated in 1862, whilst in 1868 the regulation itself was repealed.

† M. de Caux observes that for the purpose of capturing herrings the mesh of the nets since 1864 has diminished off the Norfolk coast to forty or forty-four to the yard; ten to twenty years ago five sixths of the catch were full fish, but for the last ten years the proportion has not been above two fifths, due to the change in the mesh of the net; these immature herrings will take the salt, but they will not keep.

landed the first herrings of the season: thus fishing has gradually changed from July to the third week in June, the quality being small and mostly only fit for bait. This, it is stated, prematurely disturbs the shoals and injures the future prospect of the fishing *.

As the Wick herring-fisheries from some cause diminished, those at Fraserburgh began to increase in yield. Here the same complaints were made as to the reduced size of the mesh of the nets and the taking of immature fish; but the fishing was said to commence about the middle or 20th of July, the fish being mostly taken further from shore than was formerly the case; while there is now (1878) no winter fishing except for bait. The small fish do not fetch good prices, and are often condemned as unfit for food.

In questions of migrations of fish a very important consideration must be, On what do these fishes live? for animals which afford them sustenance may, or may not, be subject to meteorological influences. Manifold and various has been the reputed diet of the herring, which, so far as I have personally observed, consists of minute entomostraca, annelids, crustacea, ova, and small fishes. Digestion is very rapid, and continued after death; consequently examinations should be instituted on very fresh examples, and the contents at once placed in spirits. The same phenomenon, as regards a false membrane forming around the food, which I observed last year occurred in the pilchard (see 'The Zoologist'), is also perceptible, but to a lesser degree, in the herring. On February 15th this year, I investigated the contents of herrings' stomachs sent to me from Mevagissey in Cornwall, by Mr. Dunn: they were taken about half a mile from land in twelve fathoms of water; they contained the remains of small crustacea &c. On May 12th in one from the same locality I found this organ distended with nineteen sand-launces (*Ammodytes*) up to two and a half inches in length, while the intestines of these small fish were of a bright orange-colour due to the crustacea which they had been consuming. From the same place, between June 10th and 14th, the stomachs of some captured about eight miles from

* The same opinion seems to have found favour at Peterhead, Aberdeen, and Montrose, that the early fishing has a bad effect on the offshore banks, increased by the repeal of the enactments against garvie fishing (see page 85), which occupation commences in November and occasionally lasts until March.

Mevagissey in six fathoms of water had changed to the fry of that excessively rare British goby *Crystallogobius Nilssoni*, the largest of which were one inch and a third long; there were also a few little herrings and sand-launces. During the last winter, off the same place Mr. Dunn observed mackerel midges (*Motella*) in the stomachs of herrings taken about eight miles from shore. Off Aberdeen I found another change, the herrings' stomachs being crammed with entomostraca and shrimps and crabs in the zoea stage; there were also two sand-launces in one herring. In most stomachs I observed some ova, apparently of fish and probably of herrings; but this is only conjecture. Many investigations, constantly carried on at different places throughout the entire herring-season, would be necessary to decide upon what this fish subsists, and whether its food exercises any influence upon the quality of its flesh. That the herring entirely ceases feeding during the time it is in full roe I satisfied myself is an error, or at any rate does not apply to the fish I examined at Aberdeen.

The breeding of this fish, or rather the period at which such occurs, is subject to very great diversity. At Wick this year (1882), early in January there were herrings full of roe; while they again spawn there in August and September. The same has been observed in the Moray Firth.

Respecting the capture of the herrings off the east coast of Scotland, it is evident that the great bulk of the fishing is carried on much further out to sea than it was a few years since. Still it does not seem at all proved that the inshore fishing has been neglected; but the probabilities are that the fish are no longer there in sufficient numbers to repay the fishermen's labour. It also seems doubtful whether the boats have really gone out so far as one hundred and ten miles herring-fishing, as asserted by some of the local fishermen; for such a distance would necessitate the captures being salted at sea, conveyed in ice, or by a more rapid mode of transit than simply sailing. During the time the 'Triton' was investigating the coast, only twice were fishing-crafts seen about one hundred miles from shore: they may have been line-fishing, or, if netting, may have been coming down the coast, seen fish, and were trying their nets. Forty miles appeared to be about the limit at which we found fleets of fishing-boats at work for herrings. Respecting the mesh of the nets employed, doubtless a difference of opinion exists, and many would like to see the old law reimposed provided the fishermen of other nations adopted it.

I am indebted to Mr. Graham, of the Scotch Fishery Board, for the figures in the following table.

Scotch Herring-Fishery Returns.

Year.	No. of boats.	Fishermen.	Barrels of herrings cured[1].	Year.	No. of boats.	Fishermen.	Barrels of herrings cured[1].
1825	10,365	44,598	379,234	1854	10,891	40,359	636,562
1826	10,958	47,371	288,495	1855	11,747	41,602	766,703
1827	11,974	47,733	399,778	1856	12,072	42,433	609,988
1828	11,166	47,953	355,979	1857	12,377	43,014	580,814
1829	11,199	48,699	329,557	1858	12,516	43,072	636,124
1830	10,980	48,373	439,370	1859	12,802	43,062	491,487
1831	11,059	49,164	362,661	1860	12,721	42,430	681,193
1832	11,008	48,181	416,964	1861	12,961	42,751	668,828
1833	11,284	49,212	451,531	1862	13,144	43,508	830,904
1834	11,359	49,462	277,317	1863	13,191	43,358	654,816
1835	11,427	49,720	497,615	1864	13,331	43,484	643,650
1836	11,494	50,253	397,829	1865	13,650	44,459	621,763
1837	11,279	50,310	507,775	1866	13,815	45,470	658,147
1838	11,357	50,238	555,560	1867	14,208	46,219	825,589
1839	11,893	50,037	543,945	1868	14,300	46,417	651,434
1840	12,422	53,939	557,262	1869[6]	14,406	45,201	675,143
1841	12,476	52,983	667,245	1870	14,935	45,712	853,160
1842	12,405	54,282	623,420	1871	15,513	46,546	825,476
1843[2]	14,067	60,457	665,360	1872	15,232	46,178	773,859
1844[3]	14,266	59,859	526,033	1873	15,095	45,594	939,233
1845	14,649	60,279	532,646	1874	14,847	45,226	1,000,561
1846	15,076	61,224	607,451	1875	14,656	45,082	942,980
1847	15,279	61,257	562,743	1876	14,547	45,263	598,197
1848	15,062	60,346	644,368	1877	14,623	45,890	847,719
1849[4]	14,962	59,792	770,698	1878	14,431	46,529	905,768
1850[5]	10,480	40,362	544,009	1879	14,457	46,502	841,796
1851	10,914	40,938	594,031	1880	14,751	47,131	1,473,600
1852	11,010	41,187	498,787	1881	14,809	48,121	1,111,155
1853	10,974	41,045	778,045				

[1] Fractions of barrels are omitted, unless exceeding $\frac{1}{2}$, when they are given as 1 barrel.

[2] Returns were from April 5th till the following April, up to 1843.

[3] Returns for 1844 ended January 5th, 1845, and so continued until 1851.

[4] Returns up to this year include those of N.E. of England.

[5] Returns from 1850 to 1868 include those of the Isle of Man.

[6] Returns from 1869 refer to Scotland only.

The foregoing table demonstrates a steady annual increase in the capture of the herrings from the commencement of this century until the present period. Everything is deemed as denoting prosperity; and should an occasional storm sweep the coast and numbers of fishermen be engulfed, such we are given to understand is an unavoidable accident, incidental to marine fisheries and incapable of remedy.

Before, however, we accept this summary method of disposing of the subject, some questions must force themselves on our notice. First of all, we are led to inquire what proportion of persons are now engaged in this occupation to the numbers that were so employed at the commencement of the present century? Do we find the augmented takes due to increased facilities of capture, larger ventures in fisheries, or simply owing to the fish being more abundant?

Mr. Graham* observes that 1825 is the earliest date in which confidence can be placed; and I find that the number of barrels of cured herrings have gradually augmented from 379 thousand cured in Scotland and the N.E. coast of England, until they have reached to upwards of a million during the last two years, while the fishermen and boys have increased by almost 4000. The proportion of the number of fishermen to barrels of herrings cured has averaged as follows:—

5	years	1825 to	1830,	1 fisherman to	8	barrels of herrings.
5	,,	1830 ,,	1835,	,,	8	,,
5	,,	1835 ,,	1840,	,,	9	,,
5	,,	1840 ,,	1845,	,,	10	,,
4	,,	1845 ,,	1849,	,,	9	,,
5	,,	1849 ,,	1854,	,,	14	,,
5	,,	1854 ,,	1859,	,,	15	,,
4	,,	1859 ,,	1863,	,,	15	,,
6	,,	1863 ,,	1869,	,,	15	,,
2	,,	1869 ,,	1871,	,,	17	,,
5	,,	1871 ,,	1876,	,,	19	,,
5	,,	1876 ,,	1881,	,,	22	,,

But when we inquire into the gear employed, we are told that cotton nets with a fivefold increased catching-surface came into use some time about 1853 (?), and have superseded the hempen ones. But the amount captured does not appear to have kept pace with these increased killing powers; for if so, the fishermen, who from 1825 to 1850 using hemp nets obtained from 8 to 10 barrels per man, should now, had the proportions continued equal, be capturing from 40 to 50 barrels instead of about 22.

* The whole of the fishermen and boys engaged in sea-fisheries are included; but as the proportion employed in the various branches continues about the same, the fluctuations would be of probably slight amount.

I would also briefly allude to another point, which is:—If herrings have, due to changes in our fishery laws, been unduly interfered with, so that the shoals are now further out to sea than was formerly the case, thus necessitating the employment of larger boats, has such occasioned, or been instrumental in occasioning, an increased loss of fishermen's lives?

That going further out in order to find and capture these fish is a necessity is now admitted, while the harbour accommodation remains unchanged: thus the larger boats now employed are unable to enter during storms, and a considerable sacrifice of life is the result.

If it had not been for the increased facilities of transit due to our railways, the cost of these fish must have risen. If the present migrations of the fish continue and they go still further off our coasts, steamers will be necessary to bring the fish in good condition on shore, or they must be salted on board. It is also questionable whether, the herrings being further out, this may not have been one reason why the haddock and inshore fisheries are likewise receding from the shore.

An important zoological question here arises, which may be briefly disposed of as follows.

It would appear from the Commissioners' report that young herrings along the east coast of Scotland were first permitted to be captured in small-meshed, sprat- or garvie-nets in 1868—the true garvie being the sprat (*Clupea sprattus*), and the young herring or whitebait belonging to *C. harengus*. Some of the witnesses averred that when the garvies are scarce many young herrings are sent away with them, while it is impossible to take garvies without taking the young herring. One witness (p. 14) asserted that he had purchased thirty barrels of garvies in one day, and found they were all young herrings. My only personal experience consists of some garvies from the north-east coast, most of which were undoubtedly young herrings. They were about three inches each in length, requiring 288 to weigh a pound, or 645,120 to the ton. In the report already referred to, we are told that 800,000,000 of herrings must be annually taken by Scotch fishermen alone, or equal to a little over 1240 tons of garvies, or young herrings, such as I have described; whilst from Inverness we are informed that in three years ending 1876–77 the Highland railway carried on an average 267 tons of garvies annually to London.

One argument, adduced in order to disprove that the destruction of fry inshore can do injury, has been that numbers of the young fish in our sandy bays and inshore grounds are possibly the offspring from some of the floating spawn shed at sea, and that it seems most likely that all the ova produced by those fishes which actually spawn in these bays are either washed ashore or drifted away. Such a conclusion is opposed to what may be seen at any time along our shores, where these minute fishes are destroyed by millions in small-meshed nets.

I would suggest, as worthy of consideration, a minute investigation of how these garvie-fisheries are carried on, and that such an examination should last through at least the whole of the month of October and until the end of January: the proportion of herrings captured to sprats, and what becomes of the captures, should be thoroughly elucidated. It would also be very desirable that such an inquiry should extend to the question of whether or not the cessation of the inshore herring-fisheries has been coincident with the extension of the garvie-fisheries.

There are it appears two chief periods when herrings appear off the east coast of Scotland, while the winter, the June, and the garvie-fisheries are partially or wholly new industries. Whether they have or have not any bearing on the cessation of the inshore herring-fisheries, I have not sufficient evidence to adduce. Still it is by no means impossible that some fishes, especially such as are gregarious, mostly return to the place where they were reared. If, therefore, from any cause the inshore race of herrings were being unduly destroyed, it does not seem an unwarrantable conclusion to draw, that such may have something to do with the deep-sea race being now the most common along the east coast of Scotland.

Dredging Operations, &c.—On June 30 we steamed from Montrose; and I must be allowed to express my thanks to Captain Tizard and the officers of H.M.S. 'Triton' for the assistance they afforded me; also to Professor Jeffrey Bell for having kindly identified the Echinodermata, to Mr. Ridley for having done the same for the Zoophytes and Sponges* (see Reports, p. 102 and p. 105), and to Mr. J. Marshall for identifying the shells.

* Dr. Malm, of Gothenburg, has kindly promised to describe the Entomostraca and also the Annelids at a future date.

At about ten miles from land, by means of a tow-net I obtained my first examples of Entomostraca.

July 1st, the tow-net yielded the same result as yesterday, but in a larger amount. From 5 A.M. and until 7 A.M. the dredge was used, having been put down in lat. 56° 40′ N. by 0° 47′ E. long., in fifty-three fathoms water having a surface-temperature of 55°, and 48½° at the bottom, which was muddy or fine sand, in which Mr. C. L. Jackson was unable to detect organic matter. A swab had been attached to either end of the dredge, by which means many sea-urchins and starfishes were secured. The result hardly showed that good feeding-ground existed at this spot. There were no fish; and among the Crustacea were three examples of *Hyas coarctatus*, and five hermit crabs (*Pagurus Bernhardus*), which inhabited dead whelks or other univalve shells. There were many of the common heart urchin and two of the fiddle heart urchin, *Brissus lyrifer*, Forbes (*Brissopsis lyrifera*, Agass.).

The Mollusca were *Mytilus phaseolinus*, Phil., *Modiolaria nigra*, Gray, several being alive as well as some of *Nucula nucleus*, Linn., *Leda minuta*, Müll., *Lucina borealis*, Linn., *Venus ovata*, *Cardium fasciatum*, Mont., *Cyprina islandica*, Linn., *Astarte sulcata*, Da Costa, *Astarte compressa*, Mont., *Dentalium entalis*, and *Psammobia ferroënsis*. There were likewise some live examples of *Venus ovata*, *Natica grœnlandica*, *Astarte compressa*, *Dentalium entalis*, Linn., *Puncturella noachina*, Linn., *Trochus alabastrum*, Bech., *Turritella terebra*, Linn., *Trophon clathratus*, Linn.

A single example of sea-mouse (*Aphrodite aculeata*), and a few living Annelids, some corallines, &c.

Dredge no. 2 was down from 5 P.M. until 7 P.M. It was put overboard in lat. 56° 54′ N. and long. 0° 33′ W., in forty-two fathoms water having a surface-temperature of 54°, and 49½° at the bottom, which was sandy and shelly. Swabs were not attached to the dredge on this occasion. The results were, comparatively speaking, somewhat larger. Fish were absent; four crabs (*Hyas coarctatus*) and more than a dozen hermit crabs; eight examples of *Hippolyte spinus*, which were bright red when first observed; three examples of a shrimp (*Crangon Allmanni*, Kinahan). Polyzoa and sponges were in large numbers; and the form popularly termed the potato sponge gave six very interesting specimens. At first sight it appeared as if a hermit crab were living inside a sponge, which possessed a smooth orifice for the crab's benefit;

but on further examples being examined, a portion of the lower surface in one or two was seen to be smooth, uncovered with sponge, and showed a shelly structure. On cutting one across it was found that the crab had originally obtained possession of a *Fusus gracilis* or *F. propinquus*: this had become coated with sponge except in that portion where constant friction, due to the movement of the crab, prevented the sponge from obtaining a hold. The substance of the shell itself had become soft.

The Mollusca consisted mostly of dead shells of *Lucina borealis*, Linn., *Cyprina islandica*, Linn., *Venus striatus*, *Solen pellucidus*, Penn., *Aporrhaïs pes-pelecani*, Linn., *Tectura testudinalis*, Müll., *Fusus islandicus*, Chemn., *Buccinum undatum*, and *Natica grœnlandica*.

July 2nd, the tow-net yielded but small returns; the day was foggy. At 1 P.M., when about three miles from shore, and in twenty fathoms of water, one of the cod fishes locally called a saithe (*Gadus virens*), weighing about 12 lb., was captured by a hand-line baited with salt junk. In its stomach I found one sand-launce (*Ammodytes*), five small haddocks, as well as a large pebble.

Dredge no. 3 was put down at 9.15 A.M., at about ten miles off Aberdeen, in lat. 57° 8′ N. and long. 1° 44′ W., in thirty-eight fathoms water, the surface-temperature being 56°, and 49° at the bottom, which consisted of mud or fine sand. There were no fish in the dredge, but more crabs than in the two preceding trials; there were nearly fifty purple heart-urchins.

The stalk-eyed Crustacea consisted of:—2 *Inachus dorsettensis*; 8 *Hyas coarctatus*, two of which had numerous ova; a small *Portunus marmoreus*; *Carcinus mænas*; 14 *Pagurus Bernhardus*, Linn.; 2 *P. Prideauxii*, Leach; 1 small *Galathea squamifera*, Mont.; 8 *Crangon Allmanni*; 4 *Hippolyte spinus*, Sow.; 4 *H. Thompsoni*; 1 *Caridina varians*, Leach; 1 *Pandalus annulicornis*, Leach; 2 *Palæmon serratus*, Penn.; and 3 *Mysis vulgaris*.

The following Mollusca were obtained:—*Anomia ephippium*; *Pecten tigrinus*, Müll.; *P. opercularis*, Linn.; *P. similis*, Laskey; *Nucula nucleus*, L.; *Leda minuta*, Müll.; *Lucina borealis*, L.; *Cardium fasciatum*, Mont.; *Cyprina islandica*, L.; *Astarte compressa*, Mont.; *A. sulcata*; *Venus ovata*, Penn.; *V. striatus* L.; *Montacuta substriata*; *Psammobia ferroënsis*, Chemn.; *Mactra elliptica*, Brown; *Thracia papyracea*, Poli; *Solen pellucidus*, Penn.; *Dentalium* *entalis*, L.; *Turritella terebra*, L.; *Natica grœnlandica*; *Fusus islandicus*, Chemn.; *Pleurotoma turricula*, Mont. That evening we anchored at Aberdeen.

July 5th, at 1.30 P.M. left Aberdeen, and at 9 P.M., when about twenty miles off Peterhead, took a mackerel midge, the young of the three-bearded rockling, in a tow-net; and I subsequently captured about half a dozen more, at distances varying from twenty to fifty miles from land. Finding these young forms almost invariably so far from land, would seem to point to the probability of the eggs, like those of the cod, being extruded some distance from the shore and floating until hatched. Mr. Sim tells me that near Aberdeen he has captured these fishes in rock-pools. As I have already remarked, they have been observed forming the food of herrings off the south-west coast of England. The evening was mild, and many large jelly-fishes were floating along past the vessel; but only a few gulls, gannets, and guillemots were seen.

July 6. Dredge no. 4 was down at 11.40 A.M., remaining until 1 P.M.; it was put overboard in lat. 57° 36′ N. and 0° 47′ E. long., in fifty-eight fathoms water having a surface-temperature of 55°, and 49° at the bottom, which consisted of fine sand. Three flatfishes (*Hippoglossoides limandoides*), the smallest being seven tenths of an inch in length, were secured, some crabs and sea-urchins. Starfishes and shells were similar to those obtained at the preceding dredge, showing a great absence among the latter of living forms; also a fair number of annelids. Corals were more abundant, and Polyzoa numerous.

The stalk-eyed Crustacea consisted of:—1 *Inachus dorsettensis*; 1 *Portunus pusillus*; 6 *Hyas coarctatus*; 10 *Galathea squamifera*, some of which were very small; 3 *Pagurus Bernhardus*; 13 *P. Prideauxii*, some of these being with ova; 2 *Hippolyte Thompsonii* also with ova; 2 *Crangon Allmanni*; 1 *Pandalus annulicornis* also with ova.

Among the Mollusca were:—*Anomia ephippium*, L.; *Pecten tigrinus*, Müll.; *Leda minuta*, Müll.; *Lucina flexuosa*, Forb. and Han.; *Cardium pygmæum*, Don.; *C. echinatum*; *Astarte sulcata*, Müll.; *A. compressa*, Mont.; *A. scotica*, Mat. and Rack.; *Venus striatum*, Humph.; *V. ovata*, Penn.; *Tapes pullastra*, Mont.; *Tellina balthica*, L.; *Saxicava rugosa*, L.; *Dentalium entalis*, L.; *Trochus alabastrum*, Bech.: numerous *Turritella terebra*, L.; *Scalaria Trevelyana*, Leach; *Fusus islandicus*. At 3.30 P.M. the lead, being brought up from $46\frac{1}{2}$ fathoms, had the valve of a *Venus striata* attached to it.

Dredge no. 5 was down at 5.20 P.M., remaining an hour. It was put overboard in lat. 57° 27′ N. by long. 1° 15′ E., in forty-eight fathoms water having a surface-temperature of 56°, and 47° at the bottom, which consisted of fine sand. A large medusa came up in the dredge—another proof how fallacious conclusions would be drawn if it were considered that all which came to the surface in an open dredge must necessarily have been obtained from the bed of the sea. Many fine jellyfishes were to be seen around the vessel; the medusæ were said by the fishermen to have been in considerable quantities at sea, off Montrose, during the preceding three weeks; they do not believe that fish eat them, but that they interfere with fishing. There were no fish, a few crabs, hermit crabs, galatheas, and shrimps, and only one live species of sea-urchin, the common heart-shaped form, of which twenty-six came up in the dredge or entangled in the swab. There were few starfishes or shells, not many annelids, some Polyzoa, sponges, &c.

July 7th. After having been rolling all night, a smart shower of rain occurred about 7.30 A.M., subsequent to which the sea went down. At 9.15 A.M., when about twenty miles from land, twenty-five herring-boats were to be seen, most of which appeared to be fishing. I obtained two more mackerel midges in the tow-net, over fifty-nine fathoms water.

Dredge no. 6 was down at 9.40 A.M., remaining until 11 A.M.; it was put overboard in lat. 57° 25′ N., and 1° 18′ W. long., in sixty fathoms water having a surface-temperture of 58°, and $49\frac{1}{2}$° at the bottom, which consisted of fine sand. Swabs were attached to the dredge. It contained no fish, some crabs, *Hyas*, hermit crabs, 2 *Hippolyte spinus*, about thirty of the common heart-urchin, upwards of a dozen starfishes belonging principally to three species, many dead but few living shells, some annelids and Polyzoa.

The Mollusca consisted of *Lucina borealis*, L., *Venus ovata*, Penn., *V. striata*, H., *Mactra elliptica*, L., *Scrobicularia prismatica*, Mont., *Psammobia ferroënsis*, *Dentalium entalis*, L., *Fusus islandicus*, and *F. propinquus*.

At 1 o'clock, just as the course of the vessel was being changed, and when only a few miles from shore, we passed a large number of saithe fish, which were dashing about as if into a shoal of herrings; gulls were likewise assisting. At 5 P.M. we arrived at Aberdeen.

July 10th, left Aberdeen at 4 A.M., and when about ten miles from port captured some very young crabs and shrimps in the tow-net, and when about twelve miles from land a mackerel midge; but up to 8.30 A.M. had only secured one small entomostracon in eight trials of the net. At 9.15 A.M., when at about twenty miles from shore, and while we were stopping for soundings, I took, in a tow-net at about a foot below the surface, a few entomostraca and a mass having somewhat the appearance of a portion of a jellyfish; but on placing it in spirit it likewise proved to be composed of minute entomostraca. At 10.30 A.M., when about twenty-five miles from shore, an embryo crab was secured.

Dredge no. 7 was put down at noon for an hour in lat. 57° 17′ N., and long. 0° 56′ W., in forty-three fathoms water having a surface-temperature of 55°, and 54° at the bottom, which consisted of sand and shell, and which was richer than that of No. 1, "consisting of fine sand, a good many pebbles, and fragments of shells. These last were very much worn, and probably never lived where found, but had been washed there. I judge thus because I cannot find a single one in good condition. There were also a few spines of Echini, and two or three common forms of Foraminifera; but the spines look also much worn, as do also the Foraminifera" (C. L. Jackson). No fish were taken. There were large numbers of the purple heart-urchin, not quite so many of the other forms; several small but no large star-fishes; a few live and many dead shells, and some annelids. Sponges were rather numerous; several were the potato sponge, containing hermit crabs, as observed upon previously; and three beautiful examples of the amphipod *Dexamine spinosa*. One jellyfish came up in the dredge.

The stalk-eyed Crustacea consisted of 1 *Stenorhynchus tenuirostris*, 1 *Ebalia Cranchii* (male), 3 small *Galatheæ*, 2 *Caridina varians* and several young, 1 *Hippolyte spinus*, 2 *H. Thompsoni*, 1 *H. Cranchii*, 3 *Crangon Allmanni*, 1 *Pandalus annulicornis*, and 8 hermit crabs of the two forms previously adverted to.

Among the Mollusca were examples of *Anomia ephippium*, L., *Pecten tigrinus*, Mont., *P. opercularis*, L., *Mytilus phaseolinus*, L., *Nucula nucleus*, L., *N. nitida*, S., *Lucina borealis*, L., *L. flexuosa*, Forb. & Han., *Cardium fasciatum*, Mont., *C. echinatum*, L., *C.*

minimum, Phil., *Cyprina islandica*, L., *Astarte compressa*, Mont., *A. sulcata*, *Venus ovata*, Penn., *V. striata*, L., *V. lineata*, *Tapes virgineus*, Linn., *Lucinopsis undata*, Penn., *Tellina balthica*, L., *Mactra elliptica*, Brown, *Scrobicularia prismatica*, Mont., *Thracia papyracea*, Poli, *Chiton cinereus*, L., *Solen pellucidus*, *Dentalium entalis*, L., *Trochus millegranus*, *Trochus tumidus*, Mont., *Turritella terebra*, L., *Natica montagui*, Forb., *N. catena*, Da Costa, *Eulima polita*, Linn., *Aporrhaïs pes-pelecani*, L., *Trichotropis borealis*, Brod. and Sow., *Buccinum undatum*, L., *Trophon clathratus*, L., *T. barvicensis*, Johnst., *Fusus Turtoni*, Bean, *F. propinquus*, Ald., *F. gracilis*, *Defrancia linearis*, Mont., *Pleurotoma turricula*, Mont., *Cypræa europæa*, Mont., and *Cylichna cylindracea*, Penn.

At 12.30 P.M., two saithe fishes, averaging about ten pounds each, were taken by hand-lines. One had no food inside it, but an old whiting-hook in its gullet. At 3 P.M. a mackerel midge was taken in the tow-net. The sea being dead calm, many jellyfishes were seen near whenever we stopped for the purpose of taking soundings. About one o'clock a third saithe was taken by a hand-line: its stomach was also destitute of food; but a strong spine was observed to have entirely pierced the stomach from the inside, and appeared to have belonged to a large grey mullet that had been swallowed.

Trawl no. 1 was down from 5.40 to 7 P.M., in lat. 57° 17′ N. and 0° 10′ W. long., in forty fathoms water having a surface-temperature of 58°, and 51° at the bottom, which was shelly. Only six purple heart urchins, one *Turritella terebra* containing a hermit crab, and three potato sponges, all containing similar crabs, were obtained.

July 11th, trawl no. 2 was down from 5 A.M. to 7 A.M. in lat. 57° 6′ N. by 1° 6′ E. long., in forty-seven fathoms water having a surface-temperature of 58°, and 49° at the bottom, which was sandy and shelly. One small sole, *Hippoglossoides*, was taken, twelve purple heart urchins, eight common heart urchins, two starfishes, and some sponges.

At 6.30 P.M. a porpoise was near the vessel, and a little later several more. At 8.30 A.M. two fishing-crafts were seen, apparently at work. The sea was very smooth during the day, and large number of jellyfishes were about. At 4.15 P.M., when about fifty-five miles from land, eight fishing-boats were in sight. Between 3 P.M. and 4 P.M. very large quantities of Entomostraca were taken in the tow-net.

Trawl no. 3 was put down from 5 P.M. to 6 P.M., in lat. 57° 7′ N. and long. 0° 37′ W., in forty fathoms water having a surface-temperature of 59°, and 32° at the bottom, which was sandy and shelly. There were taken one pogge (*Agonus cataphractus*), four soles (*Hippoglossoides*). One hundred and seventy-five purple heart urchins, some being of a large size; a few other urchins. Annelids were numerous, as also were the sea-anemones (*Actiniæ*), sponges, corals, and Polyzoa generally.

Of stalk-eyed Crustacea there were 4 *Hyas coarctatus*, 2 *Portunus pusillus*, 9 *Pagurus Bernhardus*, 2 *P. Prideauxii*, 4 *Galathea squamifera*, 2 *Hippolyte Thompsoni*.

Of Mollusca examples were taken of *Pecten tigrinus*, *P. opercularis*, *Lucina flexuosa*, *Cardium fasciatum*, *C. echinatum*, *Mytilus modiolus*, *Cyprina islandica*, *Mactra elliptica*, *Venus casina*, *V. striata*, *Saxicava arctica*, *Trochus tumidus*, *Natica catena*, *Fusus gracilis*, *F. propinquus*, and *Defrancia linearis*. Several fine whelks (*Buccinum undatum*) were also secured, and the mollusks used as bait. Some sea-anemones were found adhering to valves of *Cyprina islandica*, *Mytilus modiolus*, *Cardium echinatum*, and *Mactra elliptica*.

At 6 P.M. a shoal of mackerel midges came close to the vessel, and one was obtained in the tow-net. At about 8 P.M., when probably fifty miles from shore, many herring-boats were passed fishing. At 9 P.M. another shoal of mackerel midges passed the vessel, playing round a piece of sea-weed.

July 12th. When about four miles from shore, some young crabs and shrimps were taken in the tow-net; and at 10.30 we arrived at Aberdeen, where the herring-fishery had not yet commenced, although boats were almost daily going out herring-fishing, and returning with more or less good cargoes, some consisting of fine full fish, others of matties.

Nature of Ground traversed and Temperatures &c.—It has almost invariably been observed that waters which do not exceed a hundred fathoms in depth, termed by some naturalists the littoral zone, usually contain a large amount of life. It did not seem to me that the portion of the North Sea over which we steamed, and where we tried the dredge and the trawl, was so rich as localities I have examined elsewhere.

The nature of the ground we traversed in the 'Triton,' Captain Tizard observes, was fairly well defined, as we found a considerable area (nearly 1500 square miles) of sand and shells with gravel or small stones between the parallels of 56° 55′ and 57° 30′ at a distance of 25 to 65 miles from the shore; while around this area, except close to the coast, the bottom consists for the most part of a fine sand, approximating in some cases to hard mud.

The temperature at the bottom showed a slight decrease as the distance from the shore increased (irrespective of depth), as within twenty miles from the shore it varied from 48° to 53° in depths of from 28 to 55 fathoms, while at 100 miles from shore the range was from 46° 5′ to 50° in depths of from 46 to 56 fathoms.

In the observations taken on board the 'Triton,' and kindly furnished by Captain Tizard, the following results were observed as regards temperature:—

		Air.	Water-surface.				
June 30th.	4 a.m.	49°·8					
	8 a.m.	55·5					
	Noon.	2·8	53°·0	50°	at	47	fathoms.
	4 p.m.	53·5	52·2	49	,,	47	,,
	8 p.m.	53·5	53·7	49	,,	49	,,
	Midnight.	53·5	54·2	49	,,	41	,,
July 1st.	4 a.m.	53·0	54·0	48·5	,,	45	,,
	8 a.m.	56·5	54·7	48·5	,,	48	,,
	Noon.	62·0	56·3	49·0	,,	48	,,
	4 p.m.	55·5	56·2	49·0	,,	38	,,
	8 p.m.	52·5	54·0	49·5	,,	40	,,
	Midnight.	51·0	53·0	48·0	,,	35	,,
,, 2nd.	4 a.m.	51·0	53·0				
	8 a.m.	51·5	53·0				
	Noon.	52·5	53.0				
,, 5th.	8 p.m.	53·0	52·0	51·0	,,	55	,,
	Midnight.	54·2	54·5	51·0	,,	57	,,
,, 6th.	4 a.m.	54·0	55·0	49·0	,,	56	,,
	8 a.m.	56·2	55·0	49·0	,,	51	,,
	Noon.	61·0	55·0	49·0	,,	56	,,
	4 p.m.	58·0	56·0	49·0	,,	47	,,
	8 p.m.	56·2	55·5	48·0	,,	50	,,
	Midnight.	55·0	55·0	43·0	,,	44	,,
,, 7th.	4 a.m.	54·5	54·7	49·5	,,	49	,,
	8 a.m.	54·8	54·0	51·5	,,	37	,,
	Noon.	54·0	51·0	50·5	,,	42	,,
,, 10th.	8 a.m.	54·8	53·7	51·5	,,	43	,,
	Noon.	56·0	55·0	54·0	,,	42	,,
	4 p.m.	60·0	57·0	53.5	,,	41	,,
	8 p.m.	59·5	58·0	51·0	,,	43	,,
	Midnight.	57·0	58·0	49·0	,,	47	,,
,, 11th.	4 a.m.	57·5	57·5	50·0	,,	45	,,
	8 a.m.	59·0	58·0	46·5	,,	57	,,
	Noon.	62·5	60·0	50·5	,,	41	,,
	4 p.m.	63·5	60·0	49·0	,,	45	,,
	8 p.m.	59·5	59·0	52·0	,,	37	,,
	Midnight.	57·0	57·0	52·0	,,	49	,,
,, 12th.	4 a.m.	56·0	56·5	51·5	,,	38·5	,,
	8 a.m.	58·0	55·5	52·0	,,	51	,,

The foregoing table gives the following results:—

No. of observations.	Hour.	Temperature of air.	No. of observations.	Temperature of sea-surface.
7	4 a.m.	53°·5	6	55°·0
8	8 a.m.	55·7	7	55·8
7	Noon.	57·0	7	54·7
5	4 p.m.	58·0	5	56·0
6	8 p.m.	55·6	6	55·5
6	Midnight.	54·5	6	55·1
		55·6		55·3

The subject of mussel-beds and ground bait, which I had intended referring to, I find so comprehensively treated in a paper by Mr. Wilcock, about to be published among the prize essays of the Edinburgh Fisheries Exhibition, that I have omitted an account of this portion of my investigations.

PS.—The Rev. A. Norman having kindly examined* some of the captures made in the 'Triton,' has identified them as follows:—From the surface-net—*Anomalocera Petersonii*, Templeton, *Dias longiremis*, Lilljeborg, *Evadne Nordmanni*, Lovén, *Pondon polyphemoides*, Leuckart, and *Acanthometræ*; from the dredge—*Melita obtusata*, Montagu, *Probolium pollexianum*, Bate, *Pherusa fucicola*, Lead., *Calliopius bidentatus*, Norman, *Eurystheus erythrophthalmus*, Lilljeborg, *Cheirocratus Sundevallii*, Rathke.

Report on the Echinodermata collected by Mr. Francis Day in H.M.S. 'Triton' off the Eastern Coast of Scotland in July 1882. By Prof. F. Jeffrey Bell, M.A., F.R.M.S. (Communicated by F. Day, F.L.S.)

[Read December 21, 1882.]

A somewhat large collection of Echinodermata was made, *Spatangus purpureus* and *Asterias violacea* being very abundantly represented, as was also *Echinus elegans*, of which a very large number of small (though not one large) specimens were taken; entangled in the spines of many of these last were small egg-cases with unfertilized ova within. The Ophiurids are only six in number; and the single Holothurian is not in a condition for determination.

* Mr. Norman's memorandum was received after my paper had been read. —F. D.

The chief interest and importance of the collection seems to me to lie most in the fact that it may be taken as an earnest of what is now a very important factor in the resolution of the kind of problems that are associated with the question of the struggle for existence. When such questions as, why have these Starfishes strong spines, and those stout plates, are proposed to us, we can but give play to the imagination unless we know the kind of animals that live with them, and the kind of ground on which they live. Much of the matter to be resolved is beyond the ken of the cabinet naturalist; but I fancy that some assistance may be rendered by giving a statement of the species found at each dredging- or trawling-station, as this may hereafter be worked up when the reports of other zoologists have come to hand.

Dredge 1. *Echinus esculentus*, *E. miliaris*, *Strongylocentrotus drobachiensis*, *Echinocardium flavescens*, *Ophiopholis aculeata*.

Dredge 2. *Echinus elegans*, *E. flavescens*, *Brissopsis lyrifera*, *Cribrella oculata*, *Astropecten irregularis*, *Ophioglypha ciliata*.

Dredge 3. *Spatangus purpureus*, *Echinocardium flavescens*.

Dredge 4. *Echinus elegans*, *Spatangus purpureus*, *Echinocardium flavescens*.

Dredge 5. *E. elegans*, *E. flavescens*, *Asterias violacea*, *A. Muelleri*, *Astropecten irregularis*, *A. pentacanthus* (?) (yg.).

Dredge 6. As 5, with *Luidia Sarsi*.

Dredge 7. *Echinocyamus pusillus*, *Spatangus purpureus*, *Asterias violacea*, *Cribrella oculata*.

Trawl 3. *Echinus esculentus*, *E. flavescens*, *Sp. purpureus*, *Asterias violacea*, *Solaster endeca*, *Stichaster roseus*, *Astropecten irregularis*, *Ophioglypha ciliata*.

The finds at "Trawl 3" were more numerous than those at any other station. There were some 25 specimens of *Asterias violacea*; and the two examples of *Solaster* and the one *Cribrella* were of large size. Of twenty examples of the *Asterias* only one had lost an arm; so that if we allow anything for the dangers of the trawl, we must assume that the station under examination must be a safe place for Starfishes to inhabit. Absolutely large as the collection made at this point was, we can be by no means certain that it is proportionately so; for though it is well known that the dredger often brings up a very multitude of Echinoderms, the only kind of information given is such as can be conveyed by "scores and scores" and other vague expressions.

Even where dredgers have not the power or desire to preserve all the specimens they bring up from the deep, it would be exceedingly useful if they would sort out some of the more frequent species, and count the number lying before them: nowhere is it more true than here that "science is measurement;" and no more valuable piece of work could be done by those who are anxious to assist in the formation of a complete catalogue of our own seas. When a "few specimens from each station" are sent, it is quite impossible to say whether a multitude of *Asterias* would mean a scarcity of fishes or mollusks, or, as here, to direct attention to the fact that the station richest in *A. violacea* (Trawl 3) has no representatives of the small *Echinus elegans*, and that that Echinoid is commonest at another point (Dredge 4) where the Starfish is conspicuous by its absence. On the other hand, another Echinoid, *Spatangus purpureus*, lives freely enough with the *Asterias*; for 175 specimens are reported by Dr. Day to have been taken with Trawl 3. Indeed the region dredged over appears to be a very Paradise for *S. purpureus*, as might perhaps be expected from the sandy character of the bottom.

Put in systematic fashion, we find the collection to consist of 18 species in all, viz.:—

Echinus esculentus, *E. miliaris*, and *E. elegans*.
Strongylocentrotus drobachiensis.
Echinocyamus pusillus.
Spatangus purpureus.
Echinocardium flavescens.
Brissopsis lyrifera. Single specimen only.
Asterias violacea and *A. Muelleri*.
Stichaster roseus. Single specimen only.
Solaster endeca.
Cribrella oculata.
Astropecten irregularis and *A. pentacanthus*? (yg.).
Luidia Sarsi. Single specimen only.
Ophioglypha ciliata, and *Ophiopholis aculeata*.

Notes on Zoophytes and Sponges obtained by Mr. F. Day off the East Coast of Scotland. By Stuart O. Ridley, M.A., F.L.S.

[Read December 21, 1882.]

Specimens from two of the stations investigated by Mr. F. Day in the 'Triton' in 1882 were submitted to me for examination and report. These stations are:—1. (Dredge No. 2) Lat. 56° 54′ N., long. 0° 33′ W., or about the same latitude as Stonehaven (Kincardine); and 2. (Trawl No. 3) Lat. 57° 7′ N., long. 0° 37′ W., the latitude lying midway between Stonehaven and Aberdeen; the depth was 42 fathoms in the one case and 40 fathoms in the other, and the distance from shore considerable. Thus the ground which has contributed the specimens below noticed forms part of the great plateau of moderately deep water which surrounds Great Britain and occupies the greater part of the German Ocean, and of which the Dogger Bank and other banks are slightly elevated portions. Ground very near this was investigated by the German exploring expedition in the vessel 'Pommerania' in 1872–73*. That expedition crossed the North Sea diagonally from N.E. towards S.W., viz. from Bergen in Norway to opposite Peterhead, and then passed down the coast, at some little distance from it, and entered the Firth of Forth. The present dredgings represent perhaps somewhat more eastern localities. That expedition obtained, like the present one, comparatively few Polyzoa near this point, but, unlike it, a considerable number of species of Hydroids; of this latter group but one species is included in the material which I have examined. With the exception of the results of the German Government expedition just mentioned, and of some specimens (of *Halichondria panicea*, Johnst.) from the Dogger Bank, now in the British Museum, nothing has been, so far as I am aware, hitherto known of the Sponge-fauna of the German Ocean at a distance from the land.

Polyzoa.

The German expedition obtained *Flustra foliacea* and *Gemellaria loriculata* off Peterhead, but few between that place and the Firth. The only species which I have to mention are two.

* See 'Jahresbericht der Kommission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel.' Berlin, fol., 1875.

ALCYONIDIUM GELATINOSUM, *Linné*. Two quite small specimens.

Hab. Station 2, 40 fathoms.

Distrib. North Atlantic and Arctic seas (common) and South Africa (*Oates*).

[ALCYONIDIUM PARASITICUM, *Fleming*? A convoluted mass of dark colour, containing a considerable amount of sand between the cells. I am doubtful whether this specimen should not be referred to the Tunicata. It is attached to a shell.

Hab. Station 1, 42 fathoms.]

ANTHOZOA.

ALCYONIUM DIGITATUM, *Linné*. Abundant at both the stations. Those from Trawl No. 3 include two large specimens and one small orange-coloured example; the rest, as well as those from Dredge No. 2, were dirty white. Those from the latter source were not large. The largest specimen has enclosed in its base what appears to be a large *Balanus*.

Hab. Stations 1 & 2, 40–42 fathoms. (Also obtained by 'Pommerania.')

Distrib. North Atlantic and North-Sea coasts, common.

HYDROZOA.

The German expedition obtained a considerable variety of Hydroids here. The only species I have to notice is

HYDRACTINIA ECHINATA, *Fleming*. A small colony covers a shell which is perhaps *Littorina littorea*.

Hab. Station 2, 40 fathoms.

Distrib. Firth of Forth (common, *Herdman & Leslie**) and northern seas.

SPONGIDA.

No Sponges were obtained by the 'Pommerania' in this neighbourhood.

AMPHILECTUS EDWARDI, *Bowerbank*.

Isodictya Edwardii, *Bowerbank, Mon. Brit. Spong.* ii. p. 325; iii. pl. lviii. figs. 15–18.

Isodictya gracilis ?, *id. op. cit.* ii. p. 333; iii. pl. lviii. figs. 23–26.

Amphilectus gracilis, *Vosmaer*, pars, *Notes from the Royal Museum of the Netherlands*, ii. p. 111.

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* "The Invertebrate Fauna of the Firth of Forth," Proc. Roy. Phys. Soc. Edinb. 1881.

This sponge was obtained by Dr. Bowerbank originally in a sessile coating form on *Tubularia* from Banff. The specimen for which he established the species *Isodictya gracilis* came from Lough Larne in Ireland, and is branched, with soft stem and branches and minutely hispid surface, resembling exactly in these points the present form. Judging, however, by the figures, its skeleton-spicule is somewhat shorter and stouter, and its flesh-spicule smaller than in *I. Edwardi*; so that its identity with that species, which is asserted by Vosmaer (*l. c.*), appears to me still to require proof. At the same time it is interesting to find, as we do in the case of the present specimens, an external identity with the erect specimen from Ireland and an identity in minute structure with the Scotch specimens. Some fragments, obtained among the Hebrides, are described by Mr. Norman (Mon. Brit. Spong. iv. p. 138) as "of massive form, and showing a tendency to branch, measuring from half to three quarters of an inch long." The present specimens differ somewhat from all these specimens: they represent at least two individuals, now more or less broken. The largest must have measured quite 100 millim. (4 inches) in height when perfect; it branches subdichotomously and seldom. The stem is narrow and subcylindrical, about 5 mm. by 3 mm. in diameter; the branches also are somewhat flattened except at the apices, where they measure about 2 mm. in diameter, whereas their maximum diameter at about the middle of their course is about 7 mm. The smaller specimen is strictly cylindrical, and ranges in diameter from 2 to 4 mm. The skeleton-spicules measure about ·23 by ·008 mm.; the flesh-spicules about ·022 mm. in length.

Hab. Stations 1 & 2; 40 and 42 fathoms.

Distrib. Banff (*Bowerbank*); Hebrides (*Norman*); 1–50 fathoms.

SUBERITES FICUS, *Johnston* (? *Esper*).

Halichondria ficus, *Johnston, Brit. Spong.* p. 144, pl. xv. fig. 4.

Hymeniacidon ficus, *Bowerbank, Mon. Brit. Spong.* ii. p. 206; iii. pl. xxxvi. figs. 10–17.

Suberites ficus, *Schmidt, Spong. Atl. Gebiet.* p. 76.

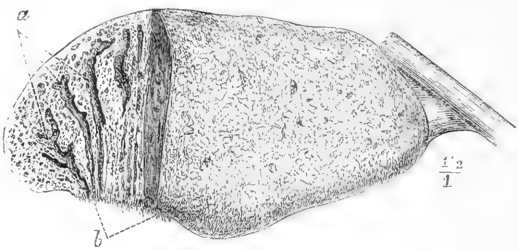
"Potato-sponge," *F. Day, Notes on the Line and Herring Fisheries,* p. 18.

Several specimens, most of which exhibit the interesting and well-known commensalism of the Sponge with *Pagurus*, the sponge growing on, and apparently causing the absorption of, the shell, while the crab lives within it.

Although it is stated by Bowerbank and Johnston that the vents ("oscula" of Bowerbank) are few and scattered (or absent altogether, *Johnston*), yet the only ficoid specimen in the present collection exhibits most distinctly a localization of these openings on the upper margin of the sponge, forming a linear series a little below its apex, in a slightly excavated depression or hilum; they measure ·5 to 1 mm. in diameter, and are apparently twenty to thirty in number; their mouths are guarded and somewhat concealed by the projection of thin laminæ of sponge-substance about 1 mm. in height, fringed with the skeleton-spicule. Dissection of the sponge shows that excretory canals converge towards and open by these orifices.

Hab. Stations 1 & 2; 40 and 42 fathoms.

Distrib. Northern, eastern, and western British and western Irish coasts; 1–50 fathoms (*Bowerbank* and *Norman*).



Suberites ficus, with the left side of the upper end removed, to show the efferent canals (*a*) and the spicular fringes (*b*) which surround their openings.

Results according to Stations.

Station 1.—Lat. 56° 54′ N., long. 0° 33′ W. 42 fathoms. Sandy and shelly bottom:—

Alcyonidium parasiticum? One specimen.
Alcyonium digitatum. Two moderate-sized white specimens.
Suberites ficus. Two small, on shells; one moderate-sized, free.
Amphilectus Edwardi. One specimen.

Station 2.—Lat. 57° 7′ N., long. 0° 37′ W. 40 fathoms. Sandy and shelly bottom:—

Alcyonidium gelatinosum. Two small, on shells.
Alcyonium digitatum. Two, large, massive and flattened, white; two smaller, white; one small, orange.
Hydractinia echinata. Covering *Littorina?* inhabited by *Pagurus.*
Suberites ficus. Two moderate-sized, on shells containing *Pagurus.* One smallish, compressed, on end of *Dentalium.*
Amphilectus Edwardi. Good-sized specimen.

Remarks on the "Manna" or Lerp Insect of South Australia. By J. G. Otto Tepper, F.L.S.

[Read February 15, 1883.]

The natural production of Australia known by the various cognomens of "Manna" by the colonists, "Lerp" by the natives of Victoria &c., and "Melitose" by others has excited frequently the inquiries of those who met with it.

Mr. George Bennett, in his work 'Gatherings of a Naturalist in Australia,' 1860, p. 272, says that the natives ascribe it to the *Tettigonia*; but adds that "it has been ascertained to be secreted by an insect of the genus *Psylla*," in which he most likely comes very near the truth.

Prof. Fred. M'Coy, describing the Great Black or Manna Cicada (*Cicada mœrens*, Germ.), in the fifth Decade of his 'Natural History of Victoria,' says (p. 55):—"This large species of *Cicada* piercing the young twigs of the Peppermint Gum-tree [of Victoria, O. T.], *Eucalyptus viminalis*, causes an abundant exudation of sap, which, drying in the hot parched air of the midsummer, leaves the sugary solid remains in a gradually increasing lump, which ultimately falls off, covering the ground with a sort of white sweet manna in little irregular masses. This peculiar kind of manna is the 'Melitose' of chemists." He gives thereby expression to the current belief in the Australian provinces, but which my observations, extending over twenty years, lead me to consider as not founded on facts in so far as this province (South Australia) is concerned.

I may mention that there are at least two different kinds of manna, if not more. The kind referred to by Mr. Bennett is entirely different in form and consistency from that referred to by Prof. M'Coy. One occurs in a solid form around the branches or on the leaves of Eucalypts, as *Eucalyptus oleosa* and *E. odorata*. The other originally exists as a moderately viscid fluid under the thin pieces of bark, peeling off, but held by their extremities, or through the insufficient slit of their converging edges, for some time to the branchlet. That *Cicadæ* produce and eject to considerable distances a viscid transparent fluid is certainly the case, as it is often proved, to the annoyance of parties who wish to enjoy their lunch in the shade of such trees the *Cicadæ* inhabit in number, as on the western slopes of the ranges near

Adelaide, the parklands of the city, &c. One finds the dead leaves, grass, &c. frequently quite coated with it; but I have hitherto failed to notice that this ejected substance is of special attraction for the ants, though very numerously present; and therefore it can scarcely be sweet. I have, besides, found it very abundant in localities where ants were very scarce, and occurring in others where I failed to find a single one.

When examining a piece of bark fresh from the tree to which some of the "melitose" is adhering, one finds the clear fluid always surrounded and frequently overspread, wholly or partially, by a fine white flocculent substance without taste, which, to a considerable extent, prevents flow of the liquid part unless when it augments to an undue degree from several closely adjoining sources. When this takes place, large round drops descend and alight upon the dry leaves, loose bark, grass, &c. scattered thickly under the tree; and on a cold fresh morning the drops are found in a more or less solid state. I have never seen this kind solid during the hot part of the day in any locality examined (Mt. Gambier, County Adelaide, Barossa Light, Fergusson), though that does not prove that the melitose of a different species of insect, and in other parts of Australia, does not solidify by heat.

On a piece of bark freshly taken from the tree a close examination shows that the fluffy white substance is thickest in the centre of a ring or oval-shaped deposit of melitose, and forms a complete or partial obstacle to any thing alive that would attempt to enter it. Carefully brushing the fluff away, a small compressed larva of an insect, evidently of very sluggish habits, is seen; and this, I have no doubt, is the real producer of the "manna." None occur where the manna is absent; and the insect is never found without at least an unmistakable trace of the melitose. Of late years both the substance and the insect appear to have become very scarce in such localities as I have examined; and therefore I have not been able satisfactorily to fix its imago; but I believe it to be a small greenish *Psylla* or related genus.

During 1879 Baron F. von Mueller requested me to turn my attention to the "Lerp" insect which chiefly produces the *solid* "manna" accumulating around the branches of Eucalypts in white scales. Acting upon his suggestion, I found the species inhabiting stunted and dwarfed shrubs of *Eucalyptus oleosa* in all its stages. Specimens were forwarded to Baron von

Mueller; but unfortunately they arrived in a state unfit for identification.

Eucalyptus oleosa is a species with an underground rootstock, from which numerous small stems, generally crooked and semi-sarmentose, spring. When these are destroyed by fire &c., a host of fresh ones spring up from the caudex; and on these, not the branches of normal and mature stems, the Lerp insect produces the manna. It consists of circular or broadly oval disks about $\frac{1}{12}$ inch diameter, convex above and concave below, formed of small irregular globules of solid melitose agglutinated, and therefore exhibiting a rough exterior surface. They are crowded around the branchlets, frequently for a length of 6 to 10 inches, and appear first as small specks in December or January. Under each is found a small larva, its short proboscis buried in the bark, and thus fixed to the spot for the period. The imago is very nimble, only about two thirds of a line in length, including its long transparent wings. Copulation takes place almost immediately after emergence.

There is found occasionally a kind of melitose on the leaves of *Eucalyptus gracilis* (solitarily), but more frequently on those of low bushes of *E. leucoxylum* in varying numbers, and in the form of extremely regular, thin scales formed of radiating curved rods united longitudinally, and resembling the half of a minute bivalve shell. These are much larger than the one described; but the species has not been sufficiently observed to do more than to mention its existence.

ADDENDUM.—Since the preceding paper was read and in type the author has forwarded a letter, of which the following is a summary of the contents:—

Referring to my communication on the Lerp insect, Baron von Mueller has lately kindly sent me the Proc. Roy. Soc. Van Diemen's Land, vol. i. (1851), which contains (p. 235) a paper on the subject by Mr. Thos. Dobson, and another (*l. c.* p. 241) on the Chemical Constitution of the Manna by Dr. Thos. Anderson. I believe, however, that neither of the Lerp insects therein described are identical with that observed by myself, though one of them may be closely related to that producing the larger symmetrical shields on leaves as noted by me. The pupa-case figured by Dobson appears quite correct, as I have seen somewhat similar perfect insects emerge from cases not unlike his. I myself have examined with a pocket-lens branchlets covered by insects in all stages; but later in the season one finds nothing but empty cases. I also am of opinion that the solid and the fluid melitose are of quite distinct origin, the latter being due to the larva previously mentioned; but the former is of more doubtful origin. It certainly is not produced by the *Cicada viminalis*, nor is it confined to *Eucalyptus viminalis*, though most abundant on that tree. It does not occur every year, nor always where the tree abounds.

[Reference may here be given to a paper on the Lerp's constructions by Mr. W. H. Wooster, Journ. Micros. Soc. Victoria, vol. i. p. 91, pl. vii. (1882).]

Mollusca of H.M.S. 'Challenger' Expedition.—Part XVII.

By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S., &c.

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[Read March 1, 1883.]

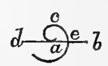
Fam. Pyramidellidæ, *Gray*.

Eulima, *Risso*. | Stylifer, *Broderip*.

Eulima.

1. *E. psila*, n. sp.
2. *E. fasciata*, n. sp.
3. *E. chaunax*, n. sp.
4. *E. chascanon*, n. sp.
5. *E. hians*, n. sp.
6. *E. ephamilla*, n. sp.
7. *E. oxytata*, n. sp.
8. *E. acanthyllis*, n. sp.
9. *E. acerrima*, n. sp.
10. *E. sarissa*, n. sp.
11. *E. latipes*, n. sp.
12. *E. famelica*, n. sp.
13. *E. chyta*, n. sp.
14. *E. campyla*, n. sp.
15. *E. fallax*, n. sp.
16. *E. chydæa*, n. sp.
17. *E. cylindrata*, n. sp.
18. *E. gomphus*, n. sp.
19. *E. hyalina*, n. sp.
20. *E. amblia*, n. sp.
21. *E. hebes*, n. sp.
22. *E. dissimilis*, n. sp.
23. *E. eurychada*, n. sp.

The tip of the apex in *Eulima* is so characteristic, that I felt it was desirable to supply the measurement of this part in each case; but it is obvious such a measurement, when taken in profile, cannot be satisfactory because of the uncertainty as to the aspect under which the observer has viewed it. I have therefore given the breadth of the first whorl as seen from a point in the line of the axis, reckoning for the first whorl here, as in all other cases, the part cut off by the line *d b*, in which case the bread this of course the distance from *a* to *c*.



Eulima, tip of the shell, *a c e*; the first whorl cut off by a straight line, *d b*. Breadth at the first whorl, *a c*.

1. Eulima psila, n. sp. (ψιλός, bare.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Off St. Thomas, N. of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Small, thin, hyaline, straight, very smooth, narrow and sharp, with longish base and mouth and small rounded tip. *Sculpture.* None whatever, the surface being perfectly smooth and glossy. *Colour* transparent glassy white. *Spire* high, narnow, and quite straight. *Apex* small, but not really sharp, being perfectly rounded and slightly set to one side. *Whorls* 10, of very regular and slow increase; quite flat. *Suture* oblique, not in the least impressed, so that the division of the whorls is only traceable from the division-walls shining through the shell. *Mouth* long, narrow, and pointedly oval. *Outer lip* rises a very little on the body-whorl, and here at the upper corner of the mouth it is slightly hollowed backward on the edge, while it advances in front to the periphery: its direction is very straight in the line of the spire's slope; on the base, which is narrow, it is extremely patulous. *Inner lip*: a very thin and undefined glaze expands on the body, which is very faintly convex, and melts without a break into the pillar, which is very slightly thickened, rounded, and twisted, and behind which lies the slightest possible furrow. H. 0·17. B. 0·04. Penultimate whorl, height 0·027. Tip of apex, breadth 0·005. Mouth, height 0·058, breadth 0·024.

This species, in the perfect flatness of its whorls, the absence of any impression of the suture, and form of the apex, greatly resembles *E. subulata*, Don.; but it is much more attenuated, the body-whorl in particular is more contracted at the periphery, and the apex is smaller and more perfectly rounded and very slightly bent to one side. In *E. bilineata*, Alder, the base of which is liker the 'Challenger' species, the whorls are slightly rounded. In *E. distorta*, Desh., var. *gracilis*, there is always some slight irregularity in the spire, and the apex is very much more minute.

2. Eulima fasciata, n. sp.

St. 24. (As above.)

Shell.—Very small, slightly bent, short; the suture is discernible on the surface and faintly banded above with white, the base is rounded, the mouth pointedly oval, the tip small and rounded. *Sculpture* none. *Colour* translucent, with an ivory band encircling the body-whorl at the periphery, and lying above the suture on the spire. *Apex* small, perfectly rounded. *Spire* rather attenuated and bent. *Whorls* 9, flat, the last rather long with a produced rounded base. *Suture* oblique, slightly impressed, especially near the apex. *Mouth* rather large, oval, pointed above. *Outer lip* a little prominently arched; on its front edge it is rather deeply sinuated above, prominent in the middle, and retreating at the base so as to form a broad, shallow, little canal in front. *Inner lip*: a very narrow rather thin glaze with a defined edge crosses the body, and runs straight down the pillar, which is very narrow and patulous, with a sharp prominent edge and a very minute furrow behind it. H. 0·096. B. 0·034. Penultimate whorl, height 0·017. Tip of apex 0·004. Mouth, height 0·03, breadth 0·017.

Than *E. Jeffreysiana*, Brus., this is a slightly stumpier form; the whorls are not in the least convex, the apex is blunter and more truncated, the outer lip is much more laterally expanded, and the basal line much more oblique. The form of the mouth and the slightly larger tip distinguish it from the young of *E. intermedia*, Cantr.

3. Eulima chaunax, n. sp. (*χαῦναξ*, a gaper, so called from the openness of the mouth.)

St. 24. (As above.)

Shell.—Small, straight, rather broad, with suture slightly impressed; whorls a very little rounded below, the last rather large and somewhat suddenly contracted; with a short flattish base, a large very open mouth, and a small rounded tip. *Sculpture* none. *Colour* translucent ivory-white. *Apex* small, rounded; but the two slopes do not perfectly agree. *Spire* shortish, perfectly straight, and with entirely similar profile-lines. *Whorls* 9, flattened above, but just perceptibly swoln below, and faintly contracting to the inferior suture; the last is a little large and contracts rather suddenly (yet not so as to form an angulation) to the constricted and flattish base. *Suture* very slightly impressed. *Mouth* large, pointedly ovate. *Outer lip* well arched and patulous; on the edge it is deeply sinuated above, prominent in the middle, and retreating in front to the point of the shell, where it forms a broad gutter with a slight projecting lip. *Inner lip*: a thin, narrow, marginated glaze spreads across the body; the pillar-edge is sharp, narrow, not patulous, very slightly oblique to the left, and is truncated in front. H. 0·15. B. 0·06. Penultimate whorl, height 0·028. Tip of apex 0·007. Mouth, height 0·05, breadth 0·036.

The proportions of the shell, its size, and the form of the mouth markedly distinguish this species from *E. fasciata*, which it slightly resembles.

4. Eulima chascanon, n. sp. (*χάσκανον*, a mask with a gaping mouth.)

St. 24. (As above.)

Shell.—High, narrow, and pliant in its lines, with a scarce visible oblique suture, short flat-sided whorls, a rounded constricted base, a very large and most patulous mouth, and a small rounded but slightly flattened and unequally sided tip. *Sculpture.* There are some microscopic soft lines of growth, which are only visible in exceptionally good light. *Colour* translucent white. *Apex* small, slightly compressed laterally, a little unequally sided, and rounded yet faintly flattened down on the tip. *Spire* high, narrow, and slightly flexuous. *Whorls* 13, not quite flat on the side; they are short and narrow, and of very slow increase; the base is a little elongated and very slightly rounded. *Suture* linear, but just perceptibly impressed; it is very distinct near the top of the spire. *Mouth* large and very open, pointedly ovate. *Outer lip* very slightly arched and patulous; on the edge it is deeply sinuated above, prominent in the middle, and retreating very little to the base, where it is extraordinarily expanded into a spoon-edged shallow canal. *Inner lip*: a very thin glaze with a most faintly defined edge extends across the body; the pillar-edge is narrow, rounded, expanded, with a very minute furrow behind it. H. 0·32. B. 0·08. Penultimate whorl, height 0·04. Tip of apex 0·004. Mouth, height 0·1, breadth 0·05.

This species in many respects resembles in form *E. gracilis*, Forb., the large variety of *E. distorta*, Desh.; but has a larger apex, a coarser suture, a more contracted, less tumid, and much more one-sided base, and a totally different mouth. Than *E. intermedia*, Cantr., it is much more attenuated.

5. Eulima hians, n. sp.

St. 24. (As above.)

Shell.—Largish, somewhat broad, with a coarsish linear suture, short flat-sided whorls, a rounded somewhat constricted base, a large patulous mouth, and a small apex. *Sculpture.* There are feeble microscopic lines of growth; along either side, not quite regularly, nor correspondingly nor uninterruptedly, are scores which mark an old mouth-edge on the succeeding whorls. *Colour* dirty white (but the specimen is a dead shell). *Apex* small, contracting rather suddenly, and in the middle the extreme tip rises into view. *Spire* high, slightly flexuous, and with not quite similar profile-lines. *Whorls* 11, just appreciably convex; the earlier ones are rounded; the last is largish, a little tumid, very faintly angulated at the periphery, with a rounded base, at the point of which the spoon-shaped mouth-front projects. *Suture* linear, slightly impressed, and for the genus a little coarse. *Mouth* large and very open, pointedly oval. *Outer lip* well arched and patulous; the edge is deeply sinuated above, slightly prominent in the middle, and retreating a little to the base, where it is expanded into a very shallow, wide, spoon-edged canal. *Inner lip*: a thinnish narrow glaze with a defined edge crosses the body, and runs out on the straight broad pillar, behind the reverted edge of which lies a strongly marked furrow. H. 0·41. B. 0·12. Penultimate whorl, height 0·06. Mouth, height 0·14, breadth 0·06.

In general form this is somewhat intermediate between *E. polita*, Linn., and *E. intermedia*, Cantr.; but the apex is much coarser, and the mouth both larger and diverse in shape. No measurement of the apical whorl is given above, in consequence of a minute crush which befell the extreme tip in the very act of taking the measurement.

6. Eulima ephamilla. (*ἐφάμιλλος*, like *E. subulata.*)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—High and narrow, very symmetrical, with a very fine linear suture, flat-sided and very little oblique whorls, a tapering scarcely convex base, and a small pear-shaped mouth. *Sculpture* none. *Colour*: the specimen is dead and discoloured. *Apex* slightly broken, but seemingly small. *Spire* high, quite straight, and with both profile-lines most symmetrical. *Whorls* 12 or 13, quite flat on the sides; the last whorl is a little long but narrow, tapering very gradually, scarcely convex, and very regularly rounded in front, where the lip hardly projects. *Suture* linear, fine and hardly impressed, and very little oblique. *Mouth* not oval, but regularly pear-shaped and slightly oblique. *Outer lip* quite straight in its direction; its edge is deeply sinuated above, a little prominent in the middle, and then it retreats very slightly to the shallow open gutter in front. *Inner lip*: a thin glaze with defined edge crosses the body and runs out on the short, narrow, slightly twisted pillar, with a very minute furrow behind it. H. 0·33. B. 0·06. Penultimate whorl, height 0·046. Mouth, height 0·07, breadth 0·05.

This species very much resembles *E. subulata*, Don., but is slightly slimmer in form, and the base in particular is more symmetrical; the sculpture is less oblique; the mouth is unmistakably different, being smaller, more drawn in towards the axis of the shell, and the inner lip has no curve on the body and no angulation at the junction of body and pillar, but runs quite straight from the angle of the mouth to the point of the pillar. Than either *E. bilineata*, Alder, or *E. gracilis*, Forb., the mouth is much smaller, the shell is much more attenuated and drawn out on the base.

7. EULIMA OXYTATA, n. sp. (*οξύτατος*, excessively sharp.)

St. 212. Jan. 30, 1875. Lat. 6° 55′ N., long. 122° 15′ E. Off Malanipa, Basilan Strait, Philippines. 10–20 fms. Sand.

Shell.—High and narrow, slightly bent, very thin and transparent, with a very fine linear suture fallaciously marginated and little oblique, flat-sided whorls, a very round base, a short round mouth, and an excessively sharp point. *Sculpture* none but occasional microscopic lines of growth. *Colour* horny translucent to transparent white. *Apex* excessively small, attenuated and sharp, acuminately rounded and almost symmetrical. *Spire* very high and narrow, not quite straight, there being more or less of a bend near the tip. *Whorls* 17, very short, perfectly flat-sided; the last is short, very slightly tumid, with a very gently and regularly curving base. *Suture* very little oblique, linear, scarcely visible on the surface, and having the appearance of being remotely marginated in consequence of the septum of the whorls shining through the thin shell. *Mouth* pear-shaped in the young shell; it is somewhat irregularly semicircular in the adult form. *Outer lip* very regularly arched except toward the lower outer corner, where there is a blunt angulation; the edge is shallowly and broadly sinuated above, prominent in the middle, and then it retreats to the shallow, open, unequal-sided gutter in front. *Inner lip* very flat on the body; there is a very slight angulation at the junction of body and pillar, which last is oblique, very short and very narrow, with a patulous but not reverted edge. H. 0·3. B. 0·07. Penultimate whorl, height 0·04. Tip of apex 0·001 to 0·002. Mouth, height 0·05, breadth 0·04.

This very beautiful form is especially remarkable for the extreme sharpness of its apex, which is not so much as half the breadth of *E. distorta*, Phil. It is slightly like *E. attenuata*, Sow., but is much slimmer, thinner in texture, more brilliant, and has a shorter and rounder mouth. Than *E. acicula*, Gd., it is very much smaller and slimmer. Than *E. rutila*, Carp., it is much slimmer, and the apex in particular is very much sharper.

8. Eulima acanthyllis, n. sp. (*ἀκανθυλλίς*, a small prickle.)

July 1875. Reef off Honolulu, Sandwich Islands. 40 fms.

Shell.—Very small, very slightly bent, transparent, with a very fine somewhat oblique suture, flat-sided whorls, a straight oblique shortish base, a pear-shaped flat-ended mouth, and an excessively sharp tip. *Sculpture* none. *Colour* pure very glossy transparent white. *Apex* quite extraordinarily small, not perfectly regular, being slightly pinched-in at the very tip, which is rounded but slightly acuminated, and not perfectly symmetrical. *Spire* very high and narrow, nearly but not quite straight, one side being slightly more oblique than the other. *Whorls* 8, almost perfectly flat-sided except towards the tip, where they are slightly rounded. *Suture* rather oblique, scarcely impressed except towards the tip, where it is a little distinct; the septum between the whorls shines through the shell, and of course makes the suture easily recognizable. *Mouth* pear-shaped, but a little truncated in front. *Outer lip* almost straight, arched at the outer basal corner, and a little straight in front; its edge is deeply sinuated above, prominent in the middle, and very retreating in front, where it forms a broad deep gutter. *Inner lip*: a thin narrow glaze with a defined edge crosses the body and extends down the pillar, on which it is expanded and slightly twisted; from the upper corner of the mouth to the point of the pillar the line is nearly straight or very slightly concave. H. 0·1. B. 0·02. Penultimate whorl, height 0·01. Tip of apex 0·002. Mouth, height 0·024, breadth 0·01.

This species, which is much smaller than *E. oxytata*, is very like a young form of that species, but it increases more rapidly, so that it has a whorl more than a specimen of *E. oxytata* of the same size; the apex is as small, but is the last thing more abruptly contracted. The *E. Manzoniana*, Issel, from the Red Sea, is larger for the number of whorls, somewhat broader in proportion to the length, the suture is less oblique, and the base is longer and more rounded.

9. Eulima acerrima, n. sp.

St. 185 *b*. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ E. Rain Island, Cape York, N. Australia. 155 fms. Sand, shells.

Shell.—Small, straight, high and narrow, translucent, with slightly impressed suture, flat-sided whorls, a long slowly attenuated and scarcely rounded base, a very long pear-shaped flat-ended mouth, and an excessively sharp tip. *Sculpture* none. *Colour* glossy, translucent white with a tinge of yellow in the middle of the whorls. *Apex* excessively minute, not quite symmetrical as the tip rises on one side. *Spire* high and narrow, almost but not quite symmetrical in its profile-lines. *Whorls* 12, very nearly quite flat-sided, but towards the tip a little convex. *Suture* rather oblique, scarcely impressed but defined by the septum, which shines through the shell. *Mouth* long, pear-shaped, but a little truncated in front. *Outer lip* scarcely in the slightest degree convex, not patulous except in front, where it forms a shallow gutter; its edge is deeply sinuated above, very prominently rounded in the middle, and slightly retreating in front. *Inner lip* almost quite straight to the point of the pillar, where the meeting with the gutter-edge is very abrupt and almost angulated; the defined-edged glaze spreads a little on the body and runs out straight on the flat and narrowly expanded pillar. H. 0·16. B. 0·04. Penultimate whorl, height 0·02. Tip of apex 0·003. Mouth, height 0·05, breadth 0·025.

Compared to *E. intermedia*, Cantr., this is a much slimmer form, with a longer more attenuated base, more curved profiles, and a much sharper apex. Than *E. oxytata* it is slimmer, the profile-lines are not quite so straight nor the individual whorls so flat, the suture is more oblique, the mouth does not project laterally, the base is smaller and longer, and the apex is not so minute nor so symmetrical.

10. Eulima sarissa, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Straight, high and narrow, rather dull, with a scarcely perceptible suture, very slightly rounded whorls, a short stumpy base, roundish mouth lying very much in the line of the axis, and with a very small symmetrical tip. *Sculpture.* There are coarsish microscopic lines of growth. *Colour* dullish white, but the shell is dead. *Apex* very small and symmetrically rounded. *Spire* narrow, straight, nearly symmetrical, but with slightly undulating profile-lines; most marked as usual near the apex, the last two whorls of which have a slight but marked contraction. *Whorls* 11, scarce perceptibly rounded. *Suture* extremely slight, and only a little oblique. *Mouth* short, broad, and rounded, pointed above, and with a broad shallow patulous gutter in front. *Outer lip* well and regularly arched; it is patulous in front, but direct above; there its edge retreats very much; it advances in the middle, and retires again toward the base. *Inner lip*: across the scarcely convex body there is a glaze with a well-defined edge; the junction of body and pillar is obtuse-angled; the pillar is short, with a rounded patulous edge. H. 0·16. B. 0·05. Penultimate whorl, height 0·02. Tip of apex 0·03. Mouth, height 0·04, breadth 0·03.

This species has not the sharp impressed suture, perfectly flat-sided whorls, and high polish of *E. intermedia*, Cantr.; is straighter and more symmetrical, the shell is thinner, the base is narrower and longer, the mouth is larger, the suture is more oblique, the apex is small but more equally rounded, not rising on one side as in that other. It is a good deal like a large form of *E. Jeffreysiana*, Brusina, but is slimmer, the whorls are not so rounded, the mouth is very much shorter and rounder, and though the apex is about the same size and form, yet the whole spire is markedly more attenuated. *E. acerrima* is slimmer, longer in the base, narrower in the mouth, and smaller in the tip. *E. oxytata*, besides other differences, has a far more attenuated spire and minute tip. *E. ephamilla* is a species with larger whorls and an impressed suture; but its greater size, the absence of young specimens, and its somewhat damaged tip make minute comparison difficult.

11. Eulima latipes, n. sp.

Sept. 8, 1874. Flinder's Passage, Torres Straits. 7 fms.

Shell.—Squat, with a broad flat base, a rapidly contracting bent spire, a small tip, convex whorls, an impressed suture, and a small pear-shaped mouth. *Sculpture* none. *Colour* glassy white. *Apex* very small, acuminately symmetrically rounded. *Spire* small and bent above, enlarging very rapidly in breadth, with concave profile-lines. *Whorls* 9, short, broad, of slow increase, slightly convex. *Suture* slight, a little impressed, scarcely oblique. *Mouth* small, pear-shaped. *Outer lip* arched, its edge retreats above, is rounded in the middle, and is patulous throughout. *Inner lip* is continuously arched across the body and down the short broad pillar. H. 0·093. B. 0·045. Penultimate whorl, height 0·015. Mouth, height 0·029, breadth 0·019.

This species is remarkable for the breadth of its base and the smallness of its tip. Unfortunately it is not very well represented, the specimen which I regard as full-grown being rubbed and chipped, and the two which are perfect being young and imperfectly developed, especially about the mouth.

12. Eulima famelica, n. sp.

St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Fayal, Azores. 450 fms. Sand.

Shell.—Slightly more cylindrical than is usual in the genus, thin, with a small direct oval mouth, a truncated rounded base, unsymmetrical profiles, whorls neither convex nor concave, yet not flat, suddenly constricted near the tip, which is small, but not fine, and is bluntly rounded. *Sculpture* none. *Colour* white, but with a horny translucency. *Apex* small, but blunt and rounded. *Spire* small, slightly bent, enlarging slowly and regularly; its profile-lines are slightly convex, but are not symmetrical. *Whorls* 11, those toward the apex are slightly convex, after the second is a rather sudden slight enlargement. *Suture* slightly impressed and rather distinct, not much oblique. *Mouth* oval, pointed above, rather small. *Outer lip* arched, slightly patulous; its edge retreats above, advances very much below, retreating again in front, where it forms a slight patulous gutter. *Inner lip* has a thickened glaze with defined edge, and is very regularly arched from the upper corner to the point of the shortish, narrow-edged pillar. H. 0·14. B. 0·04. Penultimate whorl, height 0·029. Tip of apex 0·003. Mouth, height 0·04, breadth 0·029.

The name of this species was suggested by the hungered look of the shell. It has a larger tip with a less contracted spire, a more truncated base, and a smaller broader mouth than *E. gracilis*, Forb. & Han. It most resembles *E. sarissa*; but it is, as compared to that species, slimmer, the base is much shorter, the mouth more regularly oval, the apex blunter, the spire more flexuous.

13. Eulima chyta, n. sp. (χυτός, cast.)

St. 344. April 3, 1876. Lat. 7° 24′ 20″ S., long. 14° 28′ 20″ W. Ascension Island. 420 fms. Hard ground.

Shell.—Very small, with compressed rounded outlines, glossy, with a slightly impressed suture, flat whorls, a short rounded base, oblique pear-shaped mouth, and a small blunt rounded tip. *Sculpture* none. *Colour* glossy porcellaneous white. *Apex* small, but very blunt and round *Spire* conical, unsymmetrical. *Whorls* 9, short, broad, flat; the last, which is small, is bluntly angulated at the periphery, and has a blunt rounded base. *Suture* minutely but sharply impressed. *Mouth* small, oblique, pear-shaped with a gutter in front, and altogether very like the mouth of a *Rissoina*. *Outer lip* thick and strong, but with a sharp edge; it is well arched; the edge retreats above, is very prominently rounded in the middle, and retires in front, where it is patulous. *Inner lip*: a narrow defined glaze crosses the body, which is barely convex; this glaze spreads a little at the concave base of the pillar, which is extremely short and narrow, and has a sharpish edge. H. 0·085. B. 0·03. Penultimate whorl, height 0·014. Tip of apex 0·004. Mouth, height 0·024, breadth 0·017.

This small species is like some of the small *Eulimellas*, but is a true *Eulima*.

14. Eulima campyla, n. sp. (καμπύλος, curved.)

St. 185 *b*. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ E. Rain Island, Cape York, N. Australia. 155 fms. Sand, shells.

Shell.—Subfusiform, thin, with a narrow direct semioval mouth, a long subconcave base, flat whorls, an impressed suture, slightly convex profiles, and a small blunt tip. *Sculpture*. There are a few very slight lines of growth. *Colour* hyaline to porcellaneous. *Apex* small, but very bluntly rounded, a little tumid; the extreme tip rises a little on one side. *Spire*: laterally it is straight; but the whole shell bends forward in the plane of the mouth*, and the apex has a bend over of its own. *Whorls* 9, those toward the apex are slightly convex, those lower down are less so; the earlier ones are of slow and regular increase, but the penultimate is rather long, and the last one is elongated and attenuated. *Suture* fine, slightly impressed, very little oblique; towards the lip it rises a little, a peculiarity connected with the bend of the shell toward the mouth. *Mouth* semioval, very long and narrow. *Outer lip* straight, converging toward the pillar, sweeping across the base with a very regular and even curve; the edge retreats above, but from the middle onwards is perfectly flat; in front it is very patulous and spoon-

* It is from this curved form that the name of the species is derived.

shaped, but not hollowed. *Inner lip* is a little thickened; from the upper corner of the mouth it runs straight to the point of the pillar, on which it is broadly and flatly reflected; it is abruptly angulated where it joins the basal lip. H. 0·15. B. 0·04. Penultimate whorl, height 0·03. Tip 0·004. Mouth, height 0·06, breadth 0·03.

The length of the base, the peculiar bend of the spire, and the narrow mouth cut off on the left by the straight line of the inner lip and narrower than the measurement seems to indicate, give a peculiar aspect to this shell. I know of none other which it resembles.

15. Eulima fallax, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Small, translucent, strong, rather broad, subangulated at the periphery, with a short broad flattish base, a nearly symmetrical spire, a small subtruncated rounded one-sided apex, flat whorls, a nearly invisible suture, an oblique pear-shaped mouth, and a thickened lip. *Sculpture.* There are faint microscopic lines of growth. *Colour* alabaster-white, glossy. *Apex*: the first two whorls are a little tumid and cylindrical, and the top is somewhat abrupt, being slightly tabulated with the small extreme tip but slightly projecting. *Spire* straight, with conical and nearly symmetrical profiles. *Whorls* 9, flatly conical, small, and of slow increase; the last, which is also small, is slightly oblique, and begins to contract almost from the suture; the base is broad and flattish to flatly rounded. *Suture* linear and hardly visible, but toward the apex impressed; it is scarcely at all oblique. *Mouth* pear-shaped and oblique, extremely straight on the inner lip. *Outer lip* patulous, especially in front, thickened externally, but bevelled off from the outside to a fine edge, which retreats very much above, but is roundly prominent at the periphery, below which it does not retreat, or only very slightly so toward the front of the pillar, which is crossed obliquely by a *Rissoina*-like trough. *Inner lip*: there is a narrow, patulous, thickish glaze with a defined edge which runs in a very straight line from the upper corner of the mouth to the point of the very short pillar, where it joins the outer lip at a right angle. H. 0·13. B. 0·05. Penultimate whorl, height 0·02. Tip of apex 0·004. Mouth, height 0·049, breadth 0·04.

This species seemed at first sight one already known; but the impression proved deceptive, and hence the name. The form of the spire is somewhat like *Odostomia unidentata*, Mont., whilst the mouth resembles *E. paivensis*, Watson, from Madeira. The form of the earlier whorls is faintly suggestive of the peculiar columellar tip of the spire in *Spirifer*. *E. lentiginosa*, A. Ad., from Japan, is of the same size, but has the whorls rounded, the spire smaller and bent, and the apex much sharper.

16. Eulima chydæa, n. sp. (χυδαῖος, coarse.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Smallish, translucent, strong, rather stumpy, with a short broadish rounded base, a symmetrical spire, a small bluntish rounded tip, subconvex whorls, an impressed suture, an oblique pear-shaped mouth, and a thickened lip. *Sculpture.* The whole surface is scored with faint regular microscopic longitudinal streaks. *Colour* translucent white, not very brilliant on the surface. *Apex*: the first two or three whorls are a little depressed, the tip is flatly rounded, and the extreme tip hardly rises into view. *Spire* conical, straight, with nearly symmetrical profiles. *Whorls* $7\frac{1}{2}$, of regular increase, the last alone is a little large; they are slightly convex; the base is contracted, tumid, and slightly concave. *Suture* distinct, being linearly impressed. *Mouth* short and pear-shaped. *Outer lip* thickened by an external varix, but with a fine, though blunt edge, which retreats above and is very patulous in front; in the middle of the solitary specimen it is broken. *Inner lip* thickened, concave, with a short narrowed pillar, crossed in front by a *Rissoina*-like furrow. H. 0·15. B. 0·06. Penultimate whorl, height 0·02. Tip of apex 0·004. Mouth, height 0·06, breadth 0·05.

This species slightly resembles *E. paivensis*, Watson, but is narrower, with a finer, more conical spire, flater-sided whorls, smaller apex and mouth. It has a superficial likeness to *E. fallax*; but has a coarser apex without the two papillary cylindrical first whorls of that species, its spire-profiles are more convex, there is no contraction of the body-whorl, and the mouth is larger.

The following group of *Eulimas* have a coarser apex than those which have gone before.

17. EULIMA CYLINDRATA, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Smallish, thin, glossy, attenuated, with a rounded longish base, a symmetrical spire, a blunt biggish tip, flat whorls, a scarcely visible suture, and an ovate mouth. *Sculpture.* There are very faint microscopic lines of growth, with a very feeble continuous indication of an old labial varix on successive whorls. *Colour* translucent white with a slight yellow tinge; the surface is brilliant. *Apex* is largish, blunt, and rounded, being somewhat spread out and flattened down. *Spire*: as the whorls in their growth increase very little in breadth, the breadth at the periphery is slight; and the apex being large, the form of the spire is somewhat cylindrical in comparison with other species of the genus*; it is also straight, with nearly symmetrical profiles. *Whorls* 9, of regular increase; they are all small, and not in the least convex; the base is slightly elongated and is rounded. *Suture* scarcely visible, but indicated by the interior septum. *Mouth* ovate, pointed above. *Outer lip* very regularly curved; its edge, which is sharp and thin, retreats above, is rounded and prominent in the middle, where it is slightly patulous; in front it is extremely so. *Inner lip* very direct in its oblique course from above to the point of the short pillar, where it turns over a little abruptly, joining the basal lip: there is a thin glaze on the body, and on the pillar the narrow edge is slightly reverted. H. 0·15. B. 0·04. Penultimate whorl, height 0·029. Tip of apex 0·008. Mouth, height 0·04, breadth 0·027.

The shape of this species is somewhat like that of an *Aclis*; but the texture of the shell and form of mouth are unmistakably those of *Eulima*. It is a little like *E. stenostoma*, Jeffr., but is more cylindrical and compressed, with shorter whorls and a much smaller and relatively broader mouth.

18. EULIMA GOMPHUS, n. sp. (*γόμφος*, a nail.)

St. 24. (As above.)

Shell.—Smallish, translucent, thin, glossy, rather attenuated, with a subconical base, a symmetrical spire, a biggish but bluntly-pointed tip, flat whorls, a distinct linearly impressed suture, and an oval mouth. *Sculpture.* There are many close-

* It is from this the name is derived.

set, fine, microscopic lines of growth. *Colour* translucent white, with a glossy surface. *Apex* is largish, but the first whorl contracts a little, and the extreme tip, which rises slightly on one side, is very bluntly pointed, or at least not perfectly rounded. *Spire* conical, symmetrical, with a slight sudden contraction toward the top. *Whorls* 9, of very regular increase; they are all small and not in the least convex, except the first three, which are slightly so. *Suture* a little oblique, linearly impressed, except in the case of the first three whorls, which slightly contract into the suture both above and below. *Mouth* a long oval, in its direction straight, with an open gutter in front. *Outer lip* a little flatly arched; its edge retreats very much above, forming a deep wide sinus: at the periphery it makes a very prominent advance; beyond this it scarcely retreats, but across the base projects with a very prominent patulous lip. *Inner lip*: there is a thin defined glaze across the flat body; the pillar is long and concave, with a rather broadly reverted lip which passes very gradually over into the patulous basal lip. H. 0·14. B. 0·04. Penultimate whorl, height 0·02. Tip of apex 0·008. Mouth, height 0·048, breadth 0·025.

This species is represented by eight specimens, all nearly of the same size, but they look hardly quite mature. It differs from *E. cylindrata* in being a little broader in form, more conical, and less cylindrical; the suture is distinct. The mouth and the apex in all their details are different.

19. Eulima hyalina, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Thin, hyaline, glossy, rather narrow, with a bluntish rounded base, a symmetrical spire, a biggish flattened tip, slightly convex whorls, a well-marked suture, and a short oval mouth. *Sculpture.* There are microscopic hair-like but slight lines of growth, with occasional stronger mouth-edge scars at irregular intervals, but with a recurrence of one series of them on successive whorls: these scars are like cracks in the substance of the shell. *Colour* hyaline white, scarcely clouded, and with a glassy surface. *Apex* rather large and blunt, the tip being flattened down and spread out, with a very slight rise on one side of the flatly rounded summit. *Spire* straight and symmetrical. *Whorls* 8½, of regular increase; they are a little large and slightly convex. *Suture* somewhat oblique and distinct from the slight rounding of the whorls. *Mouth* a roundish oval, pointed above and guttered in front. *Outer lip* roundly arched throughout; its thin edge retreats very much above, is roundly prominent at the periphery, and retreats toward the base, where it is very patulous. *Inner lip* scarcely convex on the body; it is slightly concave on the short patulous-edged pillar. H. 0·19. B. 0·06. Penultimate whorl, height 0·03. Tip of apex 0·01. Mouth, height 0·06, breadth 0·03.

This is a stouter form than *E. gomphus*, with shorter mouth, blunter tip, and rounder whorls. Compared to the young of *E. stenostoma*, Jeffr., this is a broader form with shorter and less oblique whorls, a much shorter and broader mouth, and a blunter tip.

20. EULIMA AMBLIA, n. sp. (ἀμβλύς, blunt.)

St. 145. Dec. 27, 1873. Lat. 46° 43′ S., long. 38° 4′ 30″ E. Halfway between Marion Island and Prince Edward Island. 50–150 fms. Grey sand.

Shell.—Small, thin, translucent or transparent, a little cylindrical, slightly bent, with a blunt tip, nearly flat-sided whorls, a very slight linear suture, and an oblong mouth. *Sculpture.* There are some very obscure microscopic lines of growth and spiral scratches. *Colour* glassy, weathering to translucent. *Spire* narrow, slightly unsymmetrical, being a little bent to the right. *Whorls* 6, short, flattened, and scarcely convex on the side; the last is somewhat long with a very blunt round base. *Suture* very slight indeed. *Mouth* oval, pointed above. *Outer lip* curved a little flatly above, but very roundly below; its edge retreats very much above and below, and is prominent at the periphery. *Inner lip* forms a continuous very slightly concave curve across the body and down the short pillar, at the point of which it is slightly angulated at its junction with the base. H. 0·125. B. 0·047. Penultimate whorl, height 0·02. Tip of apex 0·008. Mouth, height 0·04, breadth 0·026.

This species, which is represented by only one specimen and a fragment, is probably full grown. Compared to *E. distorta*, Desh., this is a narrower shell, with a much blunter apex, a longer base, a smaller mouth, and an outer lip less laterally prominent.

21. EULIMA HEBES, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Rather small, broad, blunt, slightly angulated at the periphery, straight, with conical profiles, flat-sided whorls, a slightly impressed suture, and a small angulated mouth. *Sculpture.* There are unequal, close-set, hair-like microscopic lines of growth, and faint broader spirals. *Colour* glossy ivory-white. *Apex* very blunt, rounded, with a slight projection of the extreme tip on one side. *Spire* short, conical, very slightly contracted toward the apex. *Whorls* 6, of regular increase; the last is subangulated at the periphery. *Suture* somewhat oblique, slightly impressed and distinct. *Mouth* somewhat lozenge-shaped, being pointed above and at the end of the pillar, and also at the periphery of the shell and the base of the pillar. *Outer lip* thin, angulated at its edge, retreats above and in front, and is prominent at the periphery. *Inner lip*: a thinnish defined pad stretches across the body, which is flat and expands thinly on the straight shortish pillar. H. 0·15. B. 0·07. Penultimate whorl, height 0·03. Tip of apex 0·013. Mouth, height 0·05, breadth 0·04.

This is a remarkably short and blunt form, more like an *Odostomia*, but without the characteristic apex of that genus.

22. Eulima dissimilis *, n. sp.

April 17, 1874. Port Jackson, Australia. 2–10 fms.

Shell.—Small, translucent, thin, narrow, straight, cylindrical, with a short spire, a blunt rounded tip, whorls of which the earlier are short and rounded while the last two are high and flattened, an impressed suture, and a round mouth. *Sculpture.* There are faint unequal microscopic lines of growth. *Colour* translucent, glossy white. *Apex* blunt, roundly and evenly pointed. *Spire* short, cylindrical below, roundedly conical above. *Whorls* 5½; above they are short, rounded, and of slow increase, but the last two are somewhat long, cylindrical, and of rapid enlargement; the base is long, slowly contracted, but at last rapidly rounded. *Suture* distinct, and constricted above; below it is less so. *Mouth* short and round, pointed above, patulous but not guttered in front. *Outer lip* circularly curved; its thin edge is quite level. *Inner lip* is very straight, with a thin definite-edged pad on the body and pillar, the latter of which is short. H. 0·11. B. 0·03. Penultimate whorl, height 0·026. Tip of apex 0·009. Mouth, height 0·03, breadth 0·027.

* As not like a *Eulima* at all.

This is a very aberrant form, with curious resemblances to *Rissoa epidaurica*, Brusina*, and *R. striata*, Adams, but is, I think, a true *Eulima*, and is also probably mature. It is slightly like *E. kampyla*; but is smaller and straighter, with a larger blunter apex and small round mouth.

23. EULIMA EURYCHADA, n. sp.

St. 185 *b*. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ E. Rain Island, Cape York, North Australia. 155 fms. Sand, shells.

Shell.—Small, strongish, porcellaneous, glossy white with a smoky band, somewhat like a *Pupa*-shell but more conical, straight, with a blunt tip, flat-sided whorls, a strongly impressed suture, and a small round mouth. *Sculpture.* There are obscure microscopic crowded hair-like lines of growth and finer spiral lines. *Colour* glossy porcellaneous white, banded in the middle with smoky brown which deepens to the apex. *Apex* blunt and rounded. *Spire* narrow and symmetrical, with conical profiles. *Whorls* 5½, short, of slow increase, flat-sided; but the last is slightly rounded, contracting toward the base, its whole round also diminishes in size toward the mouth. *Suture* linearly impressed; but toward the mouth the superior whorl slightly projects over it in consequence of the contraction of the shell. *Mouth* small, contracted, almost tubular, and perfectly round. *Outer lip* is very thin, and exceedingly patulous and prominent; its edge is very sinuous, retreating above and below, and advancing in the middle. *Inner lip* thick on the body, where it is very patulous, and has an advancing or slightly projecting edge, which is continuous with that of the outer lip: a shallow but well-marked furrow lies behind it, separating it from the body. H. 0·119. B. 0·05. Penultimate whorl, height 0·03. Tip of apex 0·009. Mouth, height 0·03, breadth 0·029.

This is certainly a very aberrant species of *Eulima*, and, but for the foolishness of such subdivisions, might form the basis of a new genus. The mouth is very unlike that of *Eulima*, not being at all pointed behind, and being quite round, contracted, and subtubular; but I think the species may find refuge in this genus. There are some forty or fifty specimens, which indicates that the species is abundant in the locality where it was found.

* The identification of this species with *R. glabrata*, Mühl., seems to me very doubtful.

Genus Stylifer.

Stylifer brychius, n. sp. (*βρύχιος*, from the depths.)

St. 325. March 2, 1876. Lat. 36° 44′ S., long. 46° 16′ W. South Atlantic. 2650 fms. Grey ooze. Bottom temperature 32°·7 F.

Shell.—In form somewhat like *Littorina rudis*, Maton, of the var. *tenebrosa*; but shorter in base, with a tumid and larger penultimate whorl, very thin, hyaline and glossy, with faint spirals and lines of growth: the generic pillared tip is small. *Sculpture.* Longitudinals—the whole surface is closely scored with slight obsolete and very fine threadlets, which are the lines of growth. Spirals—of these there are many, somewhat broadish but very obsolete; they are unequal, and one forms a feeble angulation considerably above the middle of the whorl. *Colour* pure glassy white, thin, and perfectly transparent. *Apex*: the style is quite straight, well defined, short and small, and consists of two whorls. *Spire* conical and rather high. *Whorls* 6, of rapid but regular increase, obliquely shouldered above from the suture to the very slight angulation, rounded below. *Suture* strong, linearly impressed, submarginated below. *Mouth* roundly pear-shaped, being shortly pointed above, large. *Outer lip* leaves the body-whorl at a right angle; it is slightly patulous, and is well arched throughout. *Inner lip* very oblique, scarcely convex above; it is very concave at the junction of the body and the pillar, which last is flattened and very slightly twisted and runs out to a very sharp edge. H. 0·5. B. 0·39. Penultimate whorl, height 0·14. Mouth, height 0·33, breadth 0·3.

The solitary specimen got of this species is preserved in spirit; but I failed to extract the animal. The shell is so delicate that no force can be used. The colour is that pale uniform buff which is so common to deep-sea Mollusca. The mantle lines the shell all round. From the middle of this projects a thickish stalked mushroom-like foot, out of the centre of which extends a long thin tongue-like process, somewhat like that figured by Gould in the 'U. S. Exploring Expedition,' pl. xiv. fig. 247, but shorter and not subulate.

In regard to the shell, it is of course hardly necessary to say that the apical "nucleus" is not "sinistral" (Ad. Gen. I. 239).

Observations on the Physiology of Echinodermata. By George J. Romanes, LL.D., F.R.S., Sec. Linn. Soc.

[Read March 1, 1883.]

Continuing the observations on the nervous system of Echinodermata which some years ago I began in conjunction with my friend Professor J. Cossar Ewart *, and then communicated to the Royal Society, I have thought that, being now Secretary of this Society, it may be more fitting that I should communicate to it the results of my further inquiries.

In the paper already published by the Royal Society, it was shown by experiment that the ocelli situated at the end of the rays in Starfish, and occupying the homologous position in Echini, perform a visual function—inducing the animal to seek the light so long as the ocelli are intact, and the animal ceasing to be affected by light when the ocelli are removed. It therefore occurred to me to try whether these organs of special sense might not have an olfactory as well as a visual function to perform. In order to try this, I procured some fresh starfish, and having placed them on a flat surface covered with shallow water, I dropped little pieces of limpet and crab in their vicinity. None of them, however, approached the food. Knowing that starfish appear to be guided to fishermen's bait by a sense of smell, I thought this result unsatisfactory; and supposing it possible that, having been freshly caught, they might not be in want of food, I left them in a tank for a couple of days, and then repeated the experiment. The result was now quite different, for the starfish began actively to crawl in the direction of the food. Selecting one individual and putting it in a large dish which was filled with sea-water, I found that I could at pleasure lead the starfish in any direction I chose by holding a morsel of crab an inch or two from the end of one of its rays, and continuously withdrawing the food as the starfish continuously approached it. Moreover I could at any time reverse the direction of advance by transferring the food to the opposite side of the animal, and holding it for a short time near the tip of a ray. Thus I could entertain no doubt that starfish have a well-developed sense of smell, which enables

* See the Croonian Lecture, 1881, Philosopical Transactions, pt. iii. 1881, pp. 829–885.

them quickly and accurately to perceive the direction from which the odour of food is coming, provided that the distance of such food as I have named is not more than a few inches from the animal.

With the view of ascertaining whether or not this olfactory sense is localized in the ocelli, I removed the latter from all the rays of the same starfish with the point of a scapel, and then repeated the experiment. The result was the same; thus showing that the ocelli are not specially concerned in the sense of smell. Next I tried the effect of removing the whole tips of the rays; but still there was no change in the result of the experiment. Nor was there any change produced when the rays were progressively truncated further and further down: the olfactory sense was found to be distributed throughout their length.

The question still remained whether this sense was equally distributed on the upper and lower surfaces of the rays. I therefore placed a piece of crab upon the upper surface of the disk of another hungry starfish, and found that the animal carried the food upon its back for any length of time without seeking to remove it with its rays, as starfish seek to remove from that position any source of irritation. I also tried the experiment of varnishing the upper surface of a starfish and placing food before its rays, with the same result as I obtained with unvarnished specimens. It was not practicable—seeing that it would have interfered with the action of the feet—to try the converse experiment of varnishing the under surface while leaving the upper surface unvarnished, or this would have supplied a still better test; but I think that the experiments which were practicable are sufficient to show that the sense of smell is distributed over the lower surface, while not extending to the upper surface.

In all these respects detached rays behave in the same way as the entire animal; but if in the entire animal the central nerve-ring is divided between each of the rays, the animal ceases to follow the food with precision, owing to the loss of coordination between the rays which the operation has entailed.

In the paper already referred to, evidence was adduced to show that, at all events, one function of the pedicellariæ is that of assisting locomotion by seizing fronds of sea-weed, and holding them steady until the pedicels have time to gain attachment by their adhesive disks. Some additional observations tending to strengthen this evidence may here be stated.

If an Echinus is allowed to form its adhesions either by its equatorial or its aboral pedicels upon a glass plate placed so as to form the cover of a tank which is filled with water, the Echinus will remain suspended in the water holding on to the glass plate, or ceiling, with as many pedicels as can be brought to bear upon that surface. From the globular shape of the animal, however, only a comparatively small number of pedicels can be thus brought to bear; and an insecurity of anchorage being the result, the Echinus seeks to increase its hold by feeling around for additional supports with its unemployed pedicels. While doing so the pedicellariæ may also be seen to be engaged in a similar quest, *and especially those near the surface of attachment*; in that vicinity the little forceps are actively swaying about and snapping, as if the animal knew that there was the best chance of encountering pieces of seaweed near the solid surface from which it is depending.

In the Royal Society paper it was stated that when an Echinus is inverted on a flat surface under water, so that it rests upon its aboral pole, it will quickly right itself by using two or more adjacent rows of pedicels. The process is thus described:—"As many feet upon the adjacent rows as can reach the floor of the tank are protruded downwards, and fastened firmly upon the floor; their combined action serves to tilt the globe slightly over in this direction—the anchoring feet on the other, or opposite, rows meanwhile releasing their hold of the tank-floor to admit of this tilting. The effect of the tilting is to allow the next feet in the active ambulacral rows to touch the floor of the tank, and when they establish their hold they assist in increasing the tilt; then the next feet in the series lay hold, and so on, till the globe slowly but steadily rises upon its equator," after which it descends as slowly into its normal position of resting upon its oral surface. Now these facts led to a discussion of the questions, whether the execution of such a manœuvre was to be considered due to the coordinating influence of a nerve-centre having a dim sense of gravity, and feeling, as it were, this sense disturbed by the unusual position in which the animal is placed; or whether the manœuvre was to be considered due merely to the serial action of the pedicels themselves, such that when the globe is slightly tilted by the combined action, say, of three successive pedicels, A, B, and C, opportunity is afforded for the next in the series, D, E, and F, to reach the floor of the tank, and, fastening upon it, to increase the tilt, so in turn affording an opportunity for the next in the series, G, H, I, to establish their adhesions, and so on. Such being the questions to determine, sundry experiments were described, with the result of tending to show that the manœuvre must at least in part be due to the coordinating influence of a nerve-centre. Mr. Francis Darwin, having read the account of these experiments, suggested an additional one, which I have tried, with the result of definitely settling the question. This experiment and its results are as follows :—

An Echinus is inverted with its aboral pole resting on the bottom of a large bottle filled to the brim with sea-water. The mouth of the bottle is then corked (no air-bubbles being included), and placed upon the rotating apparatus which Mr. Darwin and his father used for investigating the geometrism of plants. That is to say, the Echinus was continuously rotated in a vertical plane. I found that so long as the rotation was continued, whether rapidly or slowly, the Echinus did not attempt to right itself; but that, when the rotation was allowed to cease, it began to do so after two or three minutes. Moreover, if allowed to do so until it had raised itself into the equatorial, or any other intermediate position, and the rotation were then resumed, the position gained was permanently retained so long as the rotation was continued. Therefore I could entertain no doubt that the effect of the rotation was that of confusing, as it were, the coordinating influence of a nerve-centre, the stimulus to the operation of which, in the absence of rotation, is gravity. As shown in the Royal Society paper, this nerve-centre is in part, though not exclusively, the circumoral ring.

Thinking it might be worth while to try the effect of very rapid rotation upon the coordinating power of this nerve-centre, I tied the bottle containing the Echinus to the spokes of a cart-wheel, which was tilted off the ground to admit of free rotation. By means of a long rope coiled round the axle, and then uncoiled as rapidly as possible by my running away with the free end of the rope, the Echinus was submitted to exceedingly rapid rotation for two or three minutes at a time; but I could not see that, on being suddenly brought to rest, the functions of the nerve-centres were in any degree impaired.

As additional proof that the righting movements are due to a sense of gravity leading to coordinating action of the pedicels, I may mention the fact that if an Echinus is inverted in a circular beaker filled with water and of a size just sufficient to contain the animal, so that all the pedicels in all directions are equally in contact with the sides of the vessel, the animal rights itself by rotating in some one definite direction till its oral surface is in apposition with one of the sides of the beaker.

It only remains to give a short account of the effects of nerve-poisons on the Echinodermata.

1. *Chloroform.*—On mixing chloroform with the sea-water containing Echini, the first effect was to stimulate the animals to increased activity—their locomotion becoming more rapid, and their spines being moved about rapidly in all directions. But after a few minutes quiescence began to supervene, and increased till it ended in motionless torpidity—the spines and pedicellariæ being all depressed, and all irritability being suspended. When then removed to a basin containing a large quantity of sea-water without chloroform, the pedicellariæ soon began to recover their spontaneity, the stalks becoming erect and mobile, while the forceps resumed their clasping function when stimulated by the introduction of a needle between their mandibles. Next the spines recovered their reflex irritability and then their spontaneity. If the Echinus were inverted when restored to the normal sea-water, it remained inverted for a long time, shifting its position by means of its spines; but eventually it succeeded in righting itself.

2. *Caffein.*—On first immersion in a saturated solution, the pedicels of Echini exhibited a curling movement, which became progressively more and more languid, while they were at the same time slowly but imperfectly retracted. The pedicels persistently remained partly retracted, while both their spontaneity and irritability, as also those of the spines and pedicellariæ, were almost completely lost. The lantern, however, continued to be faintly responsive to stimulation. On replacing the animals in normal sea-water, they slowly recovered their irritability, and next morning were found perfectly well.

3. *Nitrite of Amyl.*—The effects, when the nitrite was added to the sea-water, were almost identical with those produced by caffein, except that the pedicels, although motionless, were not curled. On submitting an Echinus, taken out of the water and placed under a bell-jar, to the vapour of the nitrite, the action was more rapid. In both cases recovery became complete upon restoring the animals to normal sea-water.

4. *Chloral Hydrate.*—A few minutes after exposure to this substance the spines of Echini fall into confusion, and the teeth

of the animals gape widely asunder. Soon afterwards spontaneity and irritability are entirely lost. Prolonged exposure kills.

5. *Alcohol.*—The effects of alcohol are closely similar to those of chloroform, although the torpidity produced is not quite so complete.

6. *Strychnia.*—On adding some crystals of the sulphate to sea-water the first effect on the Echini was that of making their spines extend rigidly in their radial planes, which gave a striking rosette appearance to the animal. They seemed to be in a state of strain, for though they responded rapidly and strongly to stimulation, they sprang back to their original position so soon as the stimulation was discontinued. On being inverted the animals were unable to right themselves; and on being restored to normal sea-water, the spines retained their rosette arrangement for many hours. On faintly acidulating the water so as to secure a better solution of the alkaloid, the effect on the spines was that of throwing them into great disorder, while all spontaneity and irritability were destroyed. The animals were killed.

7. *Nicotin.*—A small trace of this substance added to the sea-water is sufficient to determine the speedy death of the Echini exposed to its influence, the spines being thrown into great disorder.

8. *Curare* (powder rubbed up with a few drops of spirit and distilled water before being added to the sea-water).—The Echini soon became motionless, lost their irritability, but adhered firmly with their pedicels to the floor of the tank, and when forcibly detached again resumed their hold. After a time the animals appeared to be dead, the spines being stiffly depressed but not in disorder. On being transferred to normal sea-water, however, their recovery was rapid and complete.

9. *Digitalis.*—After exposure for some time to the influence of Digitalis, the Echini lost all their spontaneity and irritability, being therefore to all appearance quite dead; but on being then restored to normal sea-water, they partly recovered. Next day they were found to be moving very languidly, their pedicels not adhering to the tank, and their general irritability being much impaired.

10. *Cyanide of Potassium.*—For some time after immersion in a very diluted solution of this substance the Echini appeared to

be none the worse; but suddenly the spines began to become depressed in a disorderly manner, while irritability ceased immediately and entirely. If the dose were not quite strong enough, or the exposure not prolonged enough to cause death, there was nevertheless a permanent weakening of the animals produced; for next day they were found to be but slightly mobile, scarcely at all responsive to stimulation, and not adhering to the tank.

Observations on the Madreporarian Family—the Fungidæ, with especial reference to the Hard Structures. By Prof. P. Martin Duncan, M.B. Lond., F.R.S., &c.

[Read January 18, 1883.]

(Plates V.–VI.)

Part I. The History of the Classification of the Fungidæ, and remarks on the Diagnosis.—Remarks on the absence of satisfactory descriptions and delineations of the Synapticula and the resulting confusion.—A description of the Hard parts of *Fungia scutaria* (variety), Lmk., general and microscopical.—Considerations regarding Growth and the Nature of the Interseptal Loculi.

The family of Aporose Madreporaria called the Fungidæ was established by Dana in 1846 in his Report on the Zoophytes of the Wilkes Exploring Expedition. He defined several genera, and gave beautiful illustrations of the general configuration of species, noticing moreover the tentacular arrangement.

In 1849 MM. Milne-Edwards and Jules Haime published a monograph on the family in the 'Annales des Sciences Naturelles,' sér. 3, tom. xv.; and, dealing rather with the hard parts than with the soft dermal tissues, they consolidated the knowledge given by Dana, and discovered some new and family peculiarities and deficiencies. They had the advantage of studying large collections of recent and fossil Fungidæ; and they saw the necessity of founding their classification on data derived both from ancient as well as modern species.

In 1860 the great work by these authors, 'L'Histoire naturelle de Coralliaires,' reached the third volume, and the Fungidæ were very carefully described and classified. They differentiated the family, explained most clearly its position in relation to the Aporosa and Perforata, and divided it into subfamilies.

This work has remained, up till lately, the recognized authority on the Fungidæ; and during twenty years very few alterations have been made in the classification. Some genera have been added, and some, like *Palæocyclus*, have been expunged; but no extension of knowledge regarding the soft or the hard structures has been recorded. Lately, however, a remarkable diversity of opinion has been expressed upon the value of one of the fundamental and family characters; and the result has been that certain palæontologists, who do not care to study recent forms, have attempted not only to separate the family from the Aporosa, but to deny the classificatory value of the structures called synapticula by MM. Milne-Edwards and Jules Haime.

I believe that these diversities of opinion are due to the want of a knowledge of the writings of the distinguished French zoophytologists in the first instance, and also to the deficiency of accurate details and definitions regarding those internal hard parts of the Fungidæ which are of primary classificatory importance.

Several modifications of the classification adopted by MM. Milne-Edwards and Jules Haime have been proposed of late years, not so much, however, from the influence of the discovery of new structures or of new views regarding the importance of old and well-known ones, as from the desire to replace the generic terms employed before the authors of 'L'Histoire naturelle des Coralliaires' wrote*. The principal change is to give the family Fungidæ the dignity of a suborder.

The classification of the group will be noticed in a future communication; but it is necessary to remember that the Fungidæ cannot be dealt with without reference to the other divisions of the Madreporaria, which is a suborder of Zoantharia. The order Zoantharia has clearly three groups in it—the Malacodermata or Actinaria, the Sclerobasica or Antipatharia, and the Sclerodermata or Madreporaria. These are very distinct suborders. They cannot be promoted to orders, as the Zoantharia are not sufficiently differentiated from others to be worthy of the position of a class. There are two groups of the Madreporaria, the Aporosa and Perforata, and the Fungidæ link them together. But the first-named groups, in consequence of the natural grouping of sets of genera in them, must be subdivided into families and subfamilies. Hence the Aporosa and Perforata are sections or

* Especially Verrill; and Klunzinger, 'Korallenthiere des Rothen Meeres,' 1879.

primary groups of Madreporaria comprising families. The Fungidæ (with their synonyms of *Fungacea*, Verrill, and *Fungiacea*, Klunzinger) have not the same zoological significance as the groups just mentioned, and cannot be placed except as a family divisible into subfamilies and genera.

Since Dana established the family Fungidæ, some fossil and recent genera which had been classified with the Aporosa have been admitted into it; but that affords no reason for an alteration of name. Moseley retains the recognized position of the Fungidæ, and so did M. de Pourtalés.

The Fungidæ as differentiated by MM. Milne-Edwards *and* Jules Haime *.—" One of the general and most striking characteristics of the species which form this family is the short and expanded growth of the corallum, whether it increases by gemmation and becomes a compound form, or whether it remains a simple one. But this tendency to a more or less horizontal development of shape is not invariable and absolute; and by itself it could not afford a satisfactory differentiation of the type, were this external character not associated with an internal structure of a very great importance. We have already seen that the interseptal loculi are either vacant down to their bases in such groups as the Turbinolidæ and Dasmidæ; or are closed at certain heights by lamellar dissepiments, as in the Oculinidæ, and principally in the Astræidæ."

" The Fungidæ present a new disposition in the structure of their interseptal loculi, which is not found in other groups. *The dissepimental tissue is completely deficient in their interseptal loculi* as in the Turbinolidæ; but the dermal sclerenchyma of the sides of the septa becomes developed in places and extends beyond the septal laminæ, *forming projections like warts or tubercles, which grow towards those of the opposite sides of the next septum and fuse.* It follows that the interseptal loculi and the visceral cavity in that position are more or less traversed, but never completely closed, by kinds of bars often of considerable dimensions. This interseptal structure differs greatly from the endothecal structure of the Astræidæ, both in its nature and analogies. We may consider the structures forming it to be analogous to extremely developed granules such as are seen in most of the septa of the Turbinolidæ, Astræidæ, and Madreporidæ. These transversely placed organs, which we have proposed

* Hist. Nat. des Corall. vol. iii. p. 1 *et seq.*

to term *synapticula*, vary a little in their shape. Usually, and we believe it is the case in all the species of the subfamily Funginæ and in most of the subfamily Lophoserinæ, where contiguous septa are forced apart, well-marked ridges placed vertically or slightly obliquely, and composed of compact sclerenchyma, are seen on the two ruptured faces. They are usually smaller in breadth here and there, or may be interrupted and separated off into series. In such genera as *Trochoseris* and *Psammoseris* these vertical rows of synapticula are made up of small bars, few in number, and they are only found low down in the interseptal loculi. But here the tendency to an appendicular growth on the faces of the septa is seen by the presence of numerous and projecting cylindro-conical and subspiniform granules.

"The synapticula appear to have escaped the notice of previous observers; and even Dana, in his beautiful illustrations in the Atlas of his great work on the Zoophytes, does not notice them in the Funginæ, and only just indicates them in some Lophoserinæ.

"In simple forms of Fungidæ the calices are usually superficial and turned down at the sides; and they are always imperfectly circumscribed in the compound forms. These increase by lateral gemmation and not by fissiparity.

"The septa, or the septocostal rays, are made up of perfect laminæ, or *they may be feebly perforate*; their free edge is invariably dentate or echinulate.

"The corallum being disciform or foliaceous, the 'walls' occupy the base of the individual, and the sclerenchymatous laminæ which constitute them are often entire and continuous; but in many other instances these laminæ are more or less perforated.

"The Fungidæ, whilst being naturally classified amongst the Aporosa, show a very clear indication of a passage into the Madreporaria perforata, which may be well seen in *Anabacia* and *Genabacia*. Moreover, the Fungidæ are readily distinguished from the preceding groups (all the other Aporosa) by the presence of synapticula; whilst their usual shape allies them with the Echinoporinæ and Merulinæ.

"The family Fungidæ is divided into two subfamilies, which are differentiated as follows:—

"The *Funginæ*, which have a disk or mural plateau without epitheca, and which is usually strongly echinulate and always more or less porous.

"The *Lophoserinæ*, in which the wall or common plateau is neither echinulate nor perforate" *.

Remarks on the Diagnosis of the Family.—Nothing can be more explicit than the family characters of the Fungidæ as established by MM. Milne-Edwards and Jules Haime; yet it is perfectly evident that they have been neglected and misinterpreted during most of the discussions which have taken place regarding the systematic position of some of the genera of Astræidæ and Fungidæ. It is manifest that in no work on the Invertebrata is there a clear and definite explanation given of what synapticula really are, in shape and method of development. The general belief is that they are large ordinary granules which meet, and thus unite together the septal laminæ on either side of an interseptal loculus, thus forming cross-bar structure. Usually it is credited that these large granules are hypertrophied ornamental granules. In fact there is no accurate description, and only one delineation of typical synapticula, in any modern work with which I am acquainted, and which treats of the general anatomy of corals.

A delineation is to be found in the last work of my lamented friend M. de Pourtalés, but unfortunately no description accompanies it. It is in the 'Report on the Florida Reefs' by Louis Agassiz, accompanied by illustrations of Florida Corals, 1880, plate xv. figs. 14 & 16. The vertical synapticula are admirably shown in fig. 14; and the well-known appearance from above, a very misleading one, is shown in figs 15 and 17.

In spite of the descriptions and delineation, it is now asserted, mainly, however, by the students of Oolitic fossil corals, that the importance and classificatory value of the synapticula is not thought to be what it was.

Nature of the Sclerenchyma of the Species of the Genus Fungia, *subfamily* Funginæ.—The shape of the Fungias and their general aspect are so well known, that it is only necessary to remark that they are not attached, have a slightly or greatly arched base, and are convex above. They may be circular or elliptical; and there is an axial fossa which is elongate in the forms with an elliptical outline. The septa are very numerous, usually large and small in succession, and the free edge is variously dentated, spined, or nearly plain.

When one of these corals is looked at from above, in its natural

* Milne-Edwards and Jules Haime, *op. cit.* vol. iii. p. 4.

position, large septa are seen radiating from the axial space to the circumference, and between them are medium-sized ones and also some very thin and extremely delicate-looking septa. The interloculi are the spaces between the septa, and which in true corals are occupied by mesenteric folds during life, and they are now seen to be empty for some little distance from the axial space and also in their upper portions. Lower down, however, and on a level with the top of the thin intermediate septum is (in every interseptal loculus) a series of structures which join the sides of approximate septa together. As each septum, of whatever size it may be, has a row of these synapticula along its sides from within outwards (from axial space to circumference), a very peculiar appearance is given to the coral, and one which has been correctly drawn by Pourtales and Klunzinger*. Each synapticulum is stout, broad from side to side, nipped in and short from within outwards. There are about eight or nine of them, with spaces separating them, elliptical in outline, in a centimetre. What is seen are the tops of the synapticula.

These cross growths are solid-looking, and they are nearly subequal, so that a very thin and leaf-like septum has great joining-structures on its sides, which are as large as those which are seen on the flanks of great primary septa. Very often the synapticula are attached to a large septum and only partly so to a very thin septum, a portion of some synapticula remaining free.

Besides these large synapticula, a very few smaller ones are seen, which may or may not reach across the interseptal space from one septum to its neighbour.

Moreover, where the very delicate septa overlap those between them their tissue is finely trabeculate.

The ornamentation of the sides of the septa is of small granules, which increase, in the form chosen as the example, in size towards the axial space of the coral; but the synapticula and the more or less imperfect growths just alluded to are independent of and *are not modified granular ornamentation.* Not a trace of dissepimental tissue stretching across the interseptal spaces and closing them is to be seen, and it does not exist in the Fungidæ proper.

When a specimen is carefully fractured across, at right angles

* The synapticular series are not visible from above near the axial fossa, but become so further out.

to the elongate central fossula and parallel with some of the large septa, the synapticula of the implicated interseptal loculi are broken across and rendered visible in their whole vertical height. They can be seen in their relation to the large and small septa. On the sides of the large septa they appear as long narrow continuous ridges separated by grooves, and having a slightly curved direction, but being in the main vertical. Starting from the flank of a large septum at some distance below its free edge, the synapticula pass downwards to the top of the dense basal wall. They may be nearly straight in vertical direction in some parts; slightly curved, concavity inwards, and often looking slightly upwards or downwards in others. Towards the outer part of the septum, and near the circumference of the coral, the curving of the synapticula, which are shorter there, is more decided than elsewhere, and the concavity is directed upwards and inwards. Near the axial space the synapticula are short in vertical measurement and curved, concavity inwards.

So that along an interseptal loculus a succession of vertical and curved ridges, one close behind the other, extends from close to the axial space to the circumference.

The extreme vertical length of the synapticula varies in the genus; and in the species under consideration it is 11 millim., and the thickness, calculated from the direction of the axis to circumference, is ·5 millim.; and forty is an extreme number of ridges to find in succession.

In a few places the vertical ridge is discontinuous, and in others the ridges may be wavy in their vertical course.

The ridges are of course synapticula broken across; and there is a groove between each successive pair, very equal in height and length from within outwards. So that a series of ridges and furrows covers the septa at a certain distance from their free edge down to the base.

On approaching the fractured surfaces and those joining the ridges together, it becomes evident that each interseptal or interlocular space is open above between the upper parts of the septa, and that below it is subdivided into numerous canal-shaped spaces, each being bounded inwards and outwards by synapticula, and on either side by septa. There is an open space also near the axis, and this is bounded externally by the first synapticulum.

The synapticula which are attached to the thin and smaller septa arise close to their free upper edge; and in all other respects resemble those of the large septa. There is a remarkable contrast between the stoutness and solidity of the synapticula and the delicacy, thinness, and often perforate and fenestrate condition of the higher orders of septa.

The smallest septa are nearly transparent, and consist of a more solid portion, which is in contact with the synapticular ridges, and of a perforated and thin portion, which corresponds with the interridge, groove, or canal. The perforations open into the canals; and thus there are more or less vertical and slightly curved alternate rows of foramina and solid structure. High up in the thin septa, and just beyond the top of the synapticula, the close part of their structure sometimes becomes almost rod-like, and broad processes arch from it on either side over foramina in the perforated portion.

Remains of this arrangement can be detected on the free edges of the larger septa, and vertical lines with curved ones between them, indicated by a denser molecular arrangement of the carbonate of lime, are to be seen on worn edges. It is evident that the fenestrate condition of the smallest septa is not permanent, and is due to incomplete development.

A tangential section across the coral near the circumference shows septa, of all sizes united by synapticula, the basal wall also a synapticulate structure, and the costæ below. As the section is vertical and the direction of the synapticula is more or less curved, they are found cut obliquely in some places, through a considerable height in others, and fairly across in many spots.

The large septa increase in width downwards to where the synapticula arise, and then diminish to the wall; and their relation to a very slender perforated septum on either size is seen to be through the medium of short stout synapticula. At the basal wall there are transverse views of large and small septa; and it is evident that, here and there, the wall is deficient, leaving spaces corresponding with the openings which may be seen on the underside of the coral between the costæ. The costæ are continuous with the septa below the wall. Now the section indicates that the wall is composed of more or less horizontal or curved synapticula, thicker than others, above; and where they are wanting, there is an opening leading upwards into an interseptal loculus, but bounded by the synapticulum above. The opening leads to a canal, and by it to the free part of the loculus. The openings are found near the circumference of the base, relate to the incoming of new septa, and fill up with age. Here and there the costæ are united by a synapticulum which stretches across from the flank of one to its next neighbour. Finally, the minute spinulose ornamentation of the sides of the septa is seen between the synapticula; and it is evident that they are different things.

Remarks on the Distribution of the Septa.—The thinnest and smallest septa (on either side of the medium septum in alternate large interseptal loculi) overtop those between them, and arch over them in the form of a finely trabeculate tissue in some places. And midway towards the axial space these more delicate septa unite to form a thick one, and this in its turn unites nearer the axis with another one formed in the same fashion. It is near those junctions that delicate trabeculæ cross the spaces between the smaller septa and act as synapticula. The thickening near the upper part of the synapticular ridges is seen in the smaller as well as in the larger septa.

If two of the thickest and tallest septa which are nearest each other at the axial space be considered limits of a system, there will be a large and slightly smaller one between them at the axis. There are primary interloculi between them. There are three very small septa in such an interloculus—that is, between each large septum and the smaller median one; and they reach, after uniting as one, close to the axial space.

The three larger septa do not have others joining them; and they pass to the margin, diverging considerably so as to admit of the origin and junction of many smaller septa; and these increase in size towards the margin according to their age or origin near the axial space. The three septa in each primary interseptal loculus reach the margin as thick ones; and so many are added towards and in the outer half of the coral between the two large septa, that no less than forty can be counted there.

The larger septa project beyond the smaller at the margin of the corallum; and every septum is continuous with a costal ridge which is denticulate, except in the instance of the very short costæ of the latest and minutest septa. About thirty large septa reach the axial space which they bound.

The young septa originate between the next older ones, or between a next older one and a much older one. They commence at the base; and it appears that synapticula are formed either prior to or simultaneously with the septum, for they and it contribute to the basal wall before the septum has increased much in height.

The additions of new septa are made with growth of the coral more and more remotely from the axis; and they are possible because of the divergence of the radially disposed larger septa.

The Columella.—The columella is composed of lax trabeculæ crowded together; and it is a very low structure at the bottom of the axial space. No additional structures are given to it by the septa, and it rests upon a thick part of the wall; and probably it is really the only part of the base which has not a synapticular origin.

The Interlocular Spaces.—It is evident that the spaces in which the soft parts are contained are very restricted. There is the axial space bounded below by the columella, and it extends between the septa only for a short distance. It is bounded up to a certain height by synapticular ridges. Above the limits of the ridges there are the interseptal loculi, whose base is at the level of the upper synapticula. But the loculi are continued to the base of the corallum along the canals formed by contiguous synapticular ridges and the septa they join together.

The interseptal loculi are therefore not closed below perfectly; but this open condition is slight, and is diminished or destroyed by growth.

One might speculate upon the impossibility of the occurrence of mesenteries, and wonder whether these forms are really corals.

It is extremely probable that the peculiar shape of the base of the Fungidæ relates to this communication between the visceral cavity and the outside*.

Histology of Hard Parts.—The microscopic appearances of this *Fungia*, in sections tangential to the septa, and which necessarily include large and small septa and synapticula, denote that, whilst some synapticula are continuous with the septal structure, others are not and are independent. When the section is rubbed down thin enough for the employment of an object-glass of 300 diameters, the septa show multitudes of dull and light

* The species of *Fungia* examined and described here is a variety of *Fungia scutaria*, Lamk., from the Red Sea and Indian Ocean. It departs from the type in the extreme minuteness of the ornamentation, the great number of septa (although this may be accounted for by growth), and the larger spines on the base. It seems to connect *Fungia paumotensis*, Stutchbury, and *F. scutaria*, both of them being members of the artificial group of genera classified by Milne-Edwards and Jules Haime as *Fungiæ subintegræ* (*op. cit.* vol. iii. p. 16).

markings, which radiate from the inner part to the sides, or from side to side, ascending obliquely and curving gradually to the edge. In some instances there is no limitation of this radiating structure at the synapticulum, the texture of which is evidently continuous with that of the septum. But in the majority of instances a dark line of separation exists at a short distance from the septal edge, and which marks off the synapticulum. The radiating fibrous-looking structure of the septum stops at this dark line. On the other hand, the fibrous appearance of the synapticulum is in a direction more or less at right angles to that of the septum; so that the dark line is bounded on one side by septal or on the other by synapticular fibrous-looking structures, which impinge on it at different angles.

Opposite to the fixture of the synapticulum to the large septum is its broad face of attachment to a thin septum of a high order; and the structures of the synapticulum are independent of, and not continuous with, the tissue of the small septum. Very commonly the thin septa break off from the synapticulum and leave it with a perfectly plane surface.

In some instances a synapticulum is marked with a line of division in its midst, midway between the septa on either side; and then one half participates in the peculiar structures of its septum, which are continued into it in the same direction.

In this last instance the synapticulum is a growth from the septum, and is continuous with it; but in the former it is an independent body joined on to two septa.

The synapticula are often grooved vertically, so as to enlarge the lumen of the canal which they help to form; and they increase beyond the normal dimensions towards the base, and unite in a homogeneous mass composing the basal wall.

The synapticula are not hypertrophied granulations, from which they differ in shape, position, and structure.

The microscopical structure of the synapticula is the same as that of the larger septa. Very thin sections show long, fusiform, very narrow fibres placed side by side, or prisms with a base and a very long body, or with a short and rapidly tapering body. In some the larger end is rounded. Certain markings are seen by transmitted light which are across the course of the fibres; but before considering their course or nature, it is necessary to remember that the fibres in a septum do not run in parallel and superimposed layers everywhere. On the contrary, there is much local and general radiation from the median line of the septum or from one edge. Moreover, these fibres are of different lengths. Hence where the fibres are not mostly fusiform, but have rounded ends or geometrically shaped terminations, they will act differently on light during its transmission through parallel planes and radiating series of them.

The common appearance is of excessively minute dark cross markings, which, under a high power and careful illumination, resolve themselves into more or less circular rings placed nearly in little linear series. The rings are dark, and have a light central part. And it appears to me that these markings are caused by the shape of the larger ends of the fibres below or above those in focus.

The thinner septa, which are so constantly seen perforated and ending above in a wave-like edge, explain the construction of the hard parts better than the sections of the larger septa. Thin septa are so delicate at the free edge, that they may be examined successfully when mounted in balsam without rubbing down previously.

The direction of the fibrous structure is exceedingly irregular; and it does not appear that there are definite vertical sets of fusiform bodies with offshoots here and there forming the sides surrounding the vacuities. There is nothing resembling microscopically the lattice-work structure seen with a low power in *Porites*, for instance, amongst the Perforate corals. But near the free edge of the thin septa the fusiform bodies and long tapering prisms project with a sharp end outwards, and are placed side by side and in series of planes one over the other. A little lower down these microscopic elements become oblique, and those on one side of a line which corresponds with the apex of a dentation on the free edge of the septum converge towards those on the other side, a vandyke or herring-bone appearance being given. Polarized light is a great assistance in this research.

In the thin portions of the youngest septa where there are fenestrations, the fibrous element does not radiate from or to them from denser parts of the septum. In many places the fibres surround, and have their long axes parallel with, the curves of the periphery of the openings; but here and there a dark line or lines which pursue an irregular, yet on the whole radiating, course from an opening have the fibres converging to them obliquely. On employing as high a magnifying-power as the section or simply mounted septum will permit, it becomes evident that the dark lines thus observed in the neighbourhood of the opening resemble those along the septa, and which end at the apex of a dentation, and others which assume a radiating appearance in the larger septa. These lines are the spaces between the fibrous elements of the hard parts in those particular spots filled with connective tissue or its remains. This need not be mistaken for tubes of *Achlya penetrans*, which are, however, seen here and there in every section of the coral.

The breadth of the fibres, which behave more like arragonite than calcite under the polarizer, is about $\frac{1}{4000}$ inch.

It would appear that the fibres of the carbonate of lime are deposited, like those of other corals, in a connective tissue, and that layer after layer is formed with more or less obliquity here and there, but not everywhere. The septa, so exceedingly delicate and porose when young, enlarge by deposit on their faces, and the perforations gradually become closed up. And it is evident that the large synapticula which are in contact with these thin septa originate irrespectively of them, and are not at first attached to them except by the medium of soft tissues. Deposit of fibrous structure occurs subsequently, and then union takes place.

The examination of this species shows that the great length and breadth of the synapticula and their forming boundaries of canals renders them only of secondary importance to the septa; and as the basal wall is composed of fused synapticula, there is no value in the observation that these structures are of little classificatory value.

Part II. The Construction of the Corallum of *Fungia echinata*, Ehr. sp.

Fungia echinata, *Ehrenberg* sp.—Haliglossa echinata, *Ehr.*—Fungia Ehrenbergi, *Dana.*—Herpetolithus Ehrenbergi, *Leuckart.*

That this remarkably elongate and echinulate form of *Fungia* should have three generic names given to it, is explanatory of the difficulty of classifying the species on account of its departing somewhat from the generic idea of *Fungia.*

The form differs from the rest of the *Fungiæ* mainly in its length in relation to breadth. In this the species resembles *Herpolitha* (*Herpetolithus*); but it is not a sufficient reason for separating it from the genus *Fungia*, especially as the species of *Fungia* already noticed in this communication is somewhat elongate. But it is evident that there is another character, which relates to the long axial fossa. MM. Milne-Edwards and Jules Haime write:—"La fossette centrale est extrêmement longue, étroite et peu profonde;"* but they do not notice that there are any rudimentary calyces along its path. Yet in the specimen now under consideration, from the Indian seas, the continuity of the fossa or axial space is interfered with by the junction across it of a large and small septum and of the rising upwards there on the median line of the columella. In fact there is such an indefinite calice in one half of the coral as may be seen in numbers along the axial space or fossa of *Herpolitha*. A corresponding structure may have been seen by Leuckart, who placed the species in that genus. Klunzinger relegates the species to the genus *Haliglossa* of Ehrenberg.

The calices seen on either side of the axial space in *Herpolitha* are not found in this species; and it must be considered a connecting form which should be placed last in the genus *Fungia* and next to *Herpolitha*.

There would be no objection to making *Haliglossa* a subgenus of *Fungia*, its character being the elongate shape and the discontinuous axial space; but I am not certain that an undeveloped calice is invariably absent in all *Fungiæ*, or present in all the specimens of *Fungia echinata*. My impression is that it is not an invariable character; and considering the singular powers of perception and the great correctness of Jules Haime, it is very probable that there was no such calice in the type described by MM. Milne-Edwards and himself. Under the circumstances, I retain the form in the genus *Fungia*.

There are some very interesting points about the anatomy of the hard parts of this coral, especially in relation to the structure of the septa and the synapticula.

On looking at the coral from above, the succession of septa is one thick septum with large dentations which are even dentate on their edges, followed by three small thin ones, of which the middle septum is slightly the thickest. The middle septum has its free edge lower than that of the large one, and it is also dentate in a minor degree; and the thin septa on both sides of it are still lower in the interseptal loculi, and have their free edges incised or very broadly and lowly dentated.

* *Op. cit.* vol. iii. p. 14.

As in the *Fungia* already noticed, there are several instances of minor septa uniting within (towards the axial space) or beyond the next largest.

Unlike the other species of *Fungia*, this form does not exhibit the rows of large synapticula separated by spaces when seen from above; and even a fracture at the side of the corallum, which removed the outer parts of the septa and exposed the interseptal loculi to some depth, only gave faint indications of their presence. Moreover, although so greatly ornamented at the free edges, the septa are comparatively free from granules on their sides low down; they are sparingly distributed in such situations on the larger septa, and very sparingly on the middle-sized ones. Higher up, and for some distance below the dentations of the larger septa, the granules often run together and form a vandyke pattern, angle upwards; and when they remain separate they assume the same shape in a series, and are large and low, especially near the inner ends of the great septa.

A transverse fracture enables the structure of the septa, synapticula, and basal wall to be seen, with granular costal spines on the base. It shows also the remarkable shape of the corallum, which has, in the specimen now under consideration, a crescentiform transverse section, and that the direction of the tall synapticula of the inner half is nearly vertical, for they do not radiate from the base. Further out and near the circumference the synapticula are more or less radial from the imaginary centre of the curve of the transverse section; but their height is small, and they are decidedly curved and often discontinuous; that is, the ridge form is deficient here and there, elongate nodules replacing it.

The larger synapticula near the axis are slightly curved and wavy in their direction, and they are slenderer than in *Fungia scutaria*. They form, however, a considerable series separated by spaces which are canals when the coral is unbroken, and their path is oblique to certain lines of depression which are directed upwards and outwards on the septa. These lines correspond with the concavities between the tall dentations, and often become slits and decided foramina, especially near the base in the septa, dividing them into palisade-looking processes.

The higher orders of septa are as cribriform as they are in the other example of *Fungia*; and solid stout synapticula attach them to the neighbouring dense and large septa. The ornamentation has not the same direction as the synapticular structures.

A thick base shows openings somewhat rarely; and in some places costæ unequal in breadth, spinulose and granular, are well seen.

The distinctions between this form and that already noticed amongst the *Fungiæ* are the more slender synapticula, their vertical position within and their discontinuous development near the circumference, and the slit-like openings in the course of large septa. It is evident that the morphology of these species of *Fungia* is very similar.

PART III. The Arrangement of the Hard Part of the Genus *Herpolitha* (*Herpetolitha* auct.).

Genus HERPOLITHA*, *Eschscholtz.*

The corallum is compound, free, long and narrow; the upper surface has indistinct calices of two kinds—one set occupy a long central line and are multilamellar; and the other are placed irregularly, have but few lamellæ, and are small. The septo-costal rays are stout and long and alternately thick and thin; none reach from the axial furrow to the circumference. The base is perforated and echinulated.

The genus may be said to embrace elongate slightly compound Fungias; and the typical species is *Herpolitha limosa*, Esper, described by Edwards and Haime (*op. cit.* vol. iii. p. 24), = *H. foliosa*, Ehrb.

The internal structures of the corallum have been hitherto undescribed, with the exception of a notice of the septa, which Milne-Edwards and Jules Haime thus describe, " leur faces montrent les cannelures verticales granulées " (their faces present vertical granulated flutings).

This is an unfortunate expression; for, taken in relation to the description of synapticula given by those authors in the first part of the diagnosis of the Fungidæ, the flutings, having of course a ridge on either side, may naturally be considered to be rows of synapticula. Indeed everybody who has the common idea of the synapticulum being an exaggerated ornamental granule will be misled, especially as the authors do not mention any synapticula in the generic diagnosis.

* *Herpetolitha* of more modern authors and restored by Klunzinger. See his excellent criticism, *op. cit.* p. 68.

A section of a corallum was made across the length, and the septa were carefully separated. The larger septa are higher than the others, and are marked on their sides (faces) by very regular vertical or slightly oblique, rather close, narrow and low, faint ridges, which carry, at close and regular intervals, distinct sharp granules with a broad base. In some places the ridges are wanting, and the granules exist in regular series all the same. In other places the ridges exist without the granules. Here and there, near the free edge of the septa, a short intermediate ridge is intercalated. The largest granulation is on the larger septa near the axial fossa; and the vertical arrangement is often replaced by an irregular one, or by concentric lines of granules and ridges.

On the outer septo-costæ near the margin of the corallum these lines of ridges and granules run upwards and outwards.

This ornamentation is found upon the thin septa, and upon all septa between the true synapticula, to which it does not present the slightest resemblance. It is a marked feature when seen from above upon the sides of the septa.

The septa are with few exceptions, which occur in the rudimentary calices, alternately large and small; and there is much arching over and joining of certain septa within and without larger ones; and in the greater part of the length of the corallum no septum which reaches the axial space extends to the margin as in *Fungia*. Usually there are three septo-costæ, one within the other, in a line from the axial space to the outer free margin of the corallum. All the septa are whole, and the perforated and immature condition of the thinnest kinds seen in the genus *Fungia* is not represented in *Herpolitha*.

The synapticula, seen from above, are rather close to the free margin of the septa, except in the case of the very large ones; and their size from within outwards is less than the elongate space which separates them from their neighbours within and without. They are numerous, regular, but wanting here and there; their obliquity is evident.

On fracturing a corallum across the length, the synapticula are seen extending from the thick basal wall upwards, in a curved series, on the flanks of the septa. The vertical position is always assumed on certain septa; but, as a rule, these growths are in gentle curves, extending much higher on the small septa than on the large. A synapticulum may extend without interruption down the whole depth of the interseptal loculus; but in the neighbourhood of the outer part of the corallum, especially, it may be discontinuous, several knobs being in a line and separated by the plain face of the septum. The direction of the curvatures is always with the concavity inwards and never outwards. The breadth of some intersynapticular spaces is greater than others.

There are some interesting modifications of the growth of the synapticula. First, these ridges are seen on the faces of some large septa, where the usual thin small septum in natural succession is partly or wholly absent. The synapticula there are of the usual size, are slightly nipped in and then expanded, and the free edge of the expansion, or that part which should have been in contact with a small septum, is a plane surface. Secondly, near the margin of the corallum the outermost synapticula close to the basal wall are in the form of irregular, broad, and high nodules, a small nodule being here and there.

The first condition indicates that the synapticulum is a growth which may be independent of origin of two opposed septa; and the second explains the continuation of the basal wall by the union of the irregular nodular and wide synapticula and their subsequent radial growth. It is evident that a thin septum may grow up and find synapticula ready for it to impinge upon and join, and that the perforations in the basal wall which usually fill up with age are openings between basal synapticula which enter, however, interseptal loculi. The union of the adjoining septa by the synapticula causes the lower parts of the interseptal loculi to be filled with a series of canals opening above, and a few opening below, as in *Fungia*; but here and there the canals are not perfect, and run one into the other laterally, or rather in an axial or circumferential direction.

Some of the most important points regarding the synapticula of *Herpolitha* are their curvature in relation to different septa, their comparative shortness, and occasional interruption and representation by lines of separate growths. It is interesting to note that these lines are not on or along those of ornamentation. There are no dissepiments in *Herpolitha.*

Where the so-called calices are seen on either side of the central axial series, a condition of the free upper margin of some of their larger septa exists which is remarkable. A separation of the septum appears to be in process, or rather two septa are forming from the old one as their base; and they are united by very curious small and numerous synapticula, which, however, can be clearly differentiated from ornament.

Finally, the columella is trabecular, and in some places, where large septa come close together, on opposite sides of the axial space, it appears to unite them together. It is partly formed by growths from their joined inner edges, and partly from structures of a trabeculate nature which spring from the original base of the young corallum.

Part IV. The Construction of *Halomitra crustacea,* Rumphius sp.

Genus Halomitra, *Dana,* 1846.—Fungia, *pars.*—Podabacia, *Milne-Edwards & Jules Haime,* 1850.

There are two genera of the Funginæ, according to Milne-Edwards and Jules Haime, which are very closely allied, namely *Podabacia* and *Halomitra*. *Halomitra* was founded by Dana in 1846, and *Podabacia* by Milne-Edwards and Jules Haime in 1850.

Halomitra, a well-defined genus, included a species which had been differently named by Rumphius, Maratti, Lamarck, and most of the writers on Corals before 1824. It is evidently one of the Funginæ, as it has a perforate base; and it departs from the configuration of the species of *Fungia* and *Herpolitha* by being compound, and by not having a long axial space and irregularly placed and rather indefinite calices.

Podabacia includes a species described by Dana and placed under the genus *Pavonia,* Lamk.; yet all the distinctions between the genera *Halomitra* and *Podabacia* are that the solitary species of the last is fixed and not free, has the base finely granular, the granules being sharp and spiny, and the smaller calices are subradiate. So that between it and *Halomitra* with a free corallum, tolerably distinct calices, and large papillæ on the base there is not a generic difference. Both groups have a large calice around which smaller ones are concentrically arranged.

MM. Milne-Edwards and Jules Haime state (*op. cit.* vol. iii. p. 20) that *Halomitra* is "très voisin du précédent (*Podabacia*), dont il ne diffère que par sa forme générale et la liberté de sa base." I therefore unite the genera, and give the name *Halomitra* to the conjoined forms, it having precedence from age.

Halomitra crustacea, a species named *Madrepora crustacea* by Pallas, is the type I have examined; and the specimen came from

Mergui*. The large central (or more or less near the edge) calice is very remarkable, and it does not appear to have been described or figured. It is a deep funnel-shaped or rather elongate calice (2 centim. long), with long septo-costæ, which pass into those of the several small calices which surround it in a ring and extend towards the circumference. The axial space is deep, and at least three times as long as it is broad (length 3 millim.); and its floor is formed by small trabeculæ from the ends of the septa. The septa are nearly horizontal at their upper parts near the edge of the calice, and they then plunge down rather rapidly to the sides of the axial space, which they bound closely. They are well developed, numerous at the outer part of the calice, and in three cycles at the axial space (24). They are distinctly separate (except at their junction parts) in the upper part of the interseptal loculi, which are very visible. The primaries are the largest and have no others united to them; the secondaries are slightly smaller, and also are usually simple and, like the primaries, reach from the margin to the axial space without being joined by any others. The tertiary septa are very compound; they are single at the axial space and bulky there; and they are composed further out of several sets of septa which unite one with the other, and each set is composed of other septa which have coalesced.

In a well-developed system the third septum is thin, straight, and long, and reaches the axial space; it is joined just without on either side by a well-developed septum at an acute angle, and still further out each of these is joined by the junction of three small septa. So that each tertiary septum is composed of an aggregate of seven septa. Hence the septal arrangement of this great calice is of five cycles in six systems. The margins or edges of the septa are profusely ornamented with well-developed dentations, some thick and others thin, and all jagged at their tops and granular at their sides. They are largest on the primary septa. The granular dentations increase in height and breadth, becoming wart-like near the outer ends of the septa and where these merge into those of the surrounding calices. The septa thus ornamented are usually, but not invariably, the higher

* The species is described in the 'Hist. Nat. des Corall.' vol. iii. p. 20; and the notes given above are upon points left unconsidered by Milne-Edwards and Jules Haime.

orders. These dentations are high, with a narrow base and expanded top, and are exceedingly rugged. Ordinarily the higher orders of septa nearer the calicular axial space have a smaller dentation than those on either side*. The slender base and more or less expanded and spinulose or knobbed extremity of the ornamentation are seen in all the dentations of the septa.

Lateral granules are seen, and they cover the flanks of the septa, especially near the free edges; some are on the sides of the dentations, and others, few in number, are on the septa below and between them. They never reach across the interseptal loculi as synapticula.

The septa and synapticula present a very remarkable appearance when viewed from the side, after the removal of a neighbouring septum and separation of the adherent synapticula. These last are large, long vertically, and very solid-looking; but the septa may either be solid and massive, or made up of trabecular processes and perforated. The curved processes forming the trabeculæ are stout, solid, and rounded, and the perforations are spaces between them. There is nothing like a thinning-off of tissue indicative of approaching deposition and filling up of a fenestration. Finally, the dentations on the upper free edge of the septa are on lines of vertical trabecular processes united at the sides; and yet the trabeculæ may join below the base of the dentation and leave a vacuity just beneath it. These vacuities are large and are commonest near the margins or free edges of the septa below the base of the dentations; but larger ones exist deeper down. The trabecular nature of parts of septa interferes with the vertical continuity of the massive synapticula; but where the septa are solid, these cross structures are high, more or less vertical or slightly curved, broad (from septum to septum), and well developed in length from within outwards. They are frequently stouter than the septal trabeculæ, and at other times are slenderer. When perfect, they have long spaces or canals between them similar to those noticed in *Fungia*, and, as in that genus, one canal may communicate with another of the next interseptal space by means of the want of solidity of the septa. When the nature of the septum is trabeculate, the synapticula are either short and restricted to the solid parts where the trabeculæ meet,

* Owing to the refractive qualities of the coral-structure these details are sometimes difficult to see. I find that soaking in a weak solution of carmine tints the white structures and gives excellent results.

or they may be high and continuous, and coincide with the septal tissue by curving here and there, and even giving forth outshoots. In a few places the synapticula are oval in section when seen at the side, small, yet much larger than any granules, and nipped-in midway when seen from above.

The minor calices surround the smaller one in several concentric rows; and the last series has long septo-costæ which reach to the thin edge of the corallum. Most of the calices are distinctly separate in their fossulæ from their fellows of the same circle; but some, whilst free, are only divided from one or both of their neighbours by a single large septum. In a very few instances the large septum does not stretch across, and is divided midway, so that the fossulæ of the calices communicate at the side. These concentric calices are shallow and small, and have six, eight, twelve, or more septa, which resemble those of the large one in their method of junction and of increase of numbers. It is evident that these calices are in organic connexion with the large central one, for its larger septo-costæ are continued into some of the smaller calices which are in their radial path. Moreover this is also the case with the higher orders of septa.

The outermost calices have their septa continued to the margin as alternately large and small and long septo-costæ; and the synapticula joining them are short, curved, and often knob-like.

There is no wall to any calice as there is in the compound corals of the Astræidæ, which separates one from the other, and the only wall is basal and synapticular.

The corallum, as a whole, is thin and consists of a more or less circular lamina fixed below, bulged out correspondingly above, and sloping down all around, and then turned up at the edge.

The under surface is marked indistinctly by radiating costæ, which are most distinct near the edge, where their relation to the septa can be seen. Between the costæ are small, round, and larger slit-like openings rather irregularly placed; and the costæ themselves are shortly granular. As in the genus *Fungia*, the basal openings are produced by defective synapticula.

The columellæ of the smaller calices are flat, and are made up of the ends of septa and are deeply seated.

The upper part of the interseptal loculi is open, and the lower portion is made up of a number of very irregular canals which communicate with each other and with the outside by means of the basal openings. The canals are less worthy of the name than in the *Fungiæ*, because of the occasional discontinuity of the synapticula.

As might be expected, such a corallum is a prey to parasitic worms, whose thin soft tubes communicate with the upper surface from below, one end being at one of the basal foramina.

The tubes stain readily, and contain spicules; and the coral-structure around has been eroded more or less. Also they have produced abnormal growth of parts of the corallum in the form of cylindrical cavities which open at the surface in the middle of the tops of septa, giving them a hollow appearance.

Part V. Summary.

The examination of species of the genera *Fungia*, *Herpolitha*, and *Halomitra* proves that they are very typical forms of the Fungidæ, and that the last genus links these members of the subfamily Funginæ on to the more trabeculate kinds.

The species have a basal wall which is more or less perforated and costulate; and sections indicate, by means of the microscope, that it is composed of the bases of septa united by synapticula. The openings, which relate partly to the radial growth of the coral, to the formation of new septa, and to imperfect development of synapticula, are frequently closed during growth.

The structures of the sclerenchyma are septa, synapticula, costæ, and a trabecular columella.

The septa are solid in *Herpolitha*, and the larger ones are solid in *Fungia*, except in the palisade-like septa of *Fungia echinata*; but in this genus the higher orders of the septa are incomplete, and irregularly cribriform or fenestrated. This perforate condition does not resemble that of the Madeporaria Perforata; and it becomes modified with age, solidity often ensuing. In *Halomitra* a trabeculate and fenestrate condition prevails.

One of the commonest features of the Fungidæ is the union of smaller septa directly with the flanks of neighbouring ones. This occurs in all the species. In *Fungia* the junction is usually on the flanks, and at the top of the septa as well, and there is a reticulate enlargement where two small lateral septa unite with one between, and which proceeds to the axis as the conjoined septum.

In *Herpolitha* the larger septa never stretch from the median line to the circumference as in *Fungia*, but two or three are in a linear series in the radial direction. Under these conditions the smaller septa, on either side of the larger, unite into one within and without it, that is to say axially and circumferentially. The union is by a V-shaped mass, more or less dense or merely linear, of delicate reticulate tissue, the transverse parts resembling delicate cross bars. The increase in numbers of septa occurs during the growth of the corallum, which takes place exogenously and at the circumference. As this enlarges, the septa which are radial have increasing breadths between them at the edge of the coral; and in the spaces thus formed septa arise from between septa at the base, and grow upwards, joining the nearest as a rule.

In *Halomitra* the junction of septa is restricted to certain parts of a calicular system; and the third septum of a system is the aggregate of several sets of smaller septa.

Next in importance to the septa are the structures which, besides forming a large part of the base, unite the septa at their sides, and in some instances the costæ also. These are the synapticula. Owing to the introductory statement regarding synapticula by their discoverers, MM. Milne-Edwards and Jules Haime, these structures are treated of by every subsequent author as ornamental granules, wart-shaped projections, and tubercles which stretch across the interseptal spaces, and unite with corresponding structures on the opposite septa, and also as the hypertrophy of the ordinary ornamental granulation of the sides of the septa, fusion taking place at junction.

In the *Funginæ* these structures are only of secondary importance to the septa; and indeed they are more solid and stronger than the higher orders of them. Moreover they modify the condition of the lower parts of each interseptal loculus.

Seen from above, the synapticula are in series in each interseptal loculus, and look like cross bars. Seen from the side, after fracturing a coral across, the synapticula are stout, nearly vertical or curved continuous ridges with a considerable vertical development. Each ridge is of course a fractured synapticulum, and is followed by a corresponding groove, one side of which is the septum bearing the synapticulum, and the base of which may be closed below, or it may open outwards by the perforations at the base. As there is a series of the synapticula in each interseptal loculus, there is a row of these ridges extending more or less from the axial space to the circumference along the septum or septa (Pl. V. fig. 1), and each ridge is separated from its neighbours by a groove. In the normal condition of the parts, each interseptal loculus is filled up in its lower part, and up to a level with the top of the smaller septa, by vertical or slightly curved solid beam-like bodies with intervening canals, some of which open through the base.

This canal-system is most complete in *Fungia* and *Herpolitha*.

The synapticula are grooved longitudinally, both axially and circumferentially, so as to enlarge the lumen of the canal; and this gives the nipped-in appearance when they are seen from above. They are very equal in size in the same corallum, exceptions to the contrary relating to immature structures; but large solid septa are united to most delicate cribriform ones by as large synapticula as are seen between well-developed septa. Again, thin fragile septa unite with each other by dense synapticula as large as those found between solid septa.

The synapticula may be seen on the side of a large septum in series, yet without a thin septum adhering to their flat free extremity; and hence the synapticulum may develop prior to one of the septa to which it will eventually become attached.

The extreme vertical height of the synapticula in *Fungia* in the specimens examined was 12–14 millim.; and they were as stout as the walls of many corals, ·5 millim. The spaces between them, or canals, are narrower.

In *Halomitra* the synapticula are long, vertical, and curved in some parts, and are a succession of linear nodules in others; and it is to be noticed that whilst in *Fungia* the perforate condition of the septa makes no difference in the continuity of the synapticula, the fenestrate condition in *Halomitra* clearly relates to their discontinuous nature.

The sides of the septa of Fungidæ examined are ornamented with granules in rows and concentric series or in vandykes. This ornamentation differs in its direction from the synapticula, and may be seen between them in some instances.

Finally, the fibrous structure of the corals, made up of very minute elongate prisms and fusiform bodies, is discontinuous here and there between septa and synapticula; and these last are often formed independently of the septa. Frequently the synapticulum is a direct offshoot of two septa; and the halves unite along a line indicated by the presence of more connective tissue than usual and by a difference in the direction of the ultimate fibres.

DESCRIPTION OF THE PLATES.

PLATE V.

Fig. 1. *Fungia echinata.* Fracture across the coral, showing palisade-like septa, cribriform septa, perforations in the base-wall, and long curved synapticula. × 2.

2. Ditto. The same, with imperfect synapticula. × 2.
3. *Fungia scutaria*, var. Fracture across the coral, showing strong nearly vertical and curved synapticula and solid and cribriform septa.
4. Section tangential to the circumference of the same specimen, showing the synapticula cut across in various parts of their course.
5. View of surface of coral, showing the tops of the synapticula in the interseptal loculi.
6. The direction of the ultimate fibrous structure in a cribriform septum. × 300.
7. The direction of the fibres in a septum and synapticula on either side; the dark wavy lines are connective tissue. × 300.
8. Part of the end of a septum with fibres resolved into crowds of spicules; tubes of *Achlya penetrans*, nobis, are parasitic. × 400.

PLATE VI.

Fig. 1. *Halomitra crustacea.* The corallum.

2. Fracture removing one septum from its neighbour, showing perforate base-wall, upright stout synapticula joining together by cross pieces; above are the ornamental granules of the free septal edge. × 3.
3. Another view, showing a stout massive synapticulum. × 3.
4. Part of a calice, showing synapticula from above. × 2.
5. The perforated base, from below. × 2.
6. *Herpolitha limosa.* A fracture, showing synapticula and basal perforations.
7. Synapticula, seen from above, between granular septa.

8. 9. 10. } Microscopic views of the spicules of *Fungia scutaria*, var. × 600. Diameter of spicule $\frac{1}{4000}$ inch.

On the Pairing of *Tegenaria Guyonii*, Guér., with a Description of certain Organs in the Abdominal Sexual Region of the Male. By F. MAULE CAMPBELL, F.L.S.

[Read February 1, 1883.]

(PLATES VII. & VIII.)

PAIRING OF TEGENARIA GUYONII (*Guér.*).

The relation between the palpi and abdominal sexual organ of male Spiders was discovered by Menge ("Ueber die Lebensweise der Arachniden," Neueste Schriften der naturf. Gesellsch. Danzig, vol. iv. 1843); and he describes the deposition of semen and its collection in the cases of *Agelena labyrinthica*, Clerck, and *Linyphia triangularis* (? *L. scalarifera*, Menge, or *L. emphana*, Walck.*). A. Ausserer ("Beobachtungen über die Lebensweise, Fortplanzung und Entwicklung der Spinnen," Zeitschr. Ferdinandeums, 1867) gives corresponding details as to *Linyphia triangularis*, Clerck, and *Dictyna benigna*, Walck. M'Cook ("Pairing of Spiders, *Linyphia marginata*," Proc. Acad. Nat. Sci. Philadelphia, 1879) appears to have seen the same process in *L. marginata*; and Blackwell briefly notes the alternate application of the palpal organs of *Agalena labyrinthica* to a "milk-white fluid" which was speedily imbibed. Bertkau ("Ueber den Generationsapparat der Araneiden," Arch. Nat. Gesch. 1875, p. 254) has related his observations on *Philoica domestica* and *Linyphia montana*. I am not aware of any other account of this primary sexual act, which, in consequence of its short duration, can only be witnessed through good fortune or the most constant attention.

The varied forms of the palpi of male spiders, and their length relatively to their distance from the opening of the abdominal sexual organ, suggest the great probability of more or less difference in the process according to the species. The character of the palpi must also govern the mode of actual union, which in the case of *Tegenaria Guyonii* has also not hitherto been described.

The Deposition of Semen.—A male *T. Guyonii* which had been imprisoned a month cast its skin on the 28th of July and gained maturity. I did not observe it make any movement until the 5th of August; and three blowflies which had been given it remained untouched. On that day I placed the bottle which contained it uncovered inside another in which was a female. She had been mature a fortnight. The male soon became conscious of her presence, and approached her. Wishing to see if his attention could be diverted by food after his long abstinence, and fearing he might attack the female, I dropped close to him a daddy-long-legs, which he quickly seized. The following morning he was standing with the first pair of legs over the female and his maxillæ resting on her abdomen, while she was crouching motionless with her head in an opposite direction. Both were

* See Thorell's 'Remarks on Synonyms of European Spiders,' p. 48.

in the same position the next morning (7th August, 7 A.M.). A 10 A.M. he became restless, and wandered, with spinnerets extended, about the bottle, returning every now and then to place his palpi on the female. After each such occasion he jerked his abdomen upwards and downwards, a movement* which I have often noticed in males, both mature and immature, and which gives the idea of an expression of impatience. I was called away for a few minutes, and on returning found the male about two inches behind the female, standing as it were on tip-toe. The palpi were now placed alternately and nervously to the maxillæ. On their removal the whole body was raised still higher, and the abdomen brought nearly to a right angle with the cephalothorax, with considerable muscular effort in the basal portion and with violent tremulations. The movements, which were repeated four times, had the effect of throwing the spider slightly forward, while the palpi were shaken in that peculiar manner which denotes great muscular tension in some other part than that in visible motion. The palpi were now (generally alternately) placed under the sternum, and moved backwards and forwards, upwards and downwards with a scooping motion. In five minutes these movements of the abdomen and palpi were repeated ten times in regular succession, only varied by an occasional transfer of the digital organs to the mouth. It was only during the last moments of the process that reflected light enabled me to see a triangular silken sheet attached to the spider behind the abdominal sexual organ by its apex, and by its external angles to the mesh across the bottle. The sheet extended from under the abdomen to the anterior part of the sternum and lay *above* the palpi. The male now left the sheet and approached the female; but she appeared mindless of his addresses. I now seized him; and in his attempts to evade capture he injured the silken sheet. An examination showed that the sides consisted of many shreds (fig. 19, A), while the intervening space was covered with an irregular mesh (fig. 20, natural size), which was doubtless originally more systematically arranged. Here and there was a mass of semen containing a fine granulated substance (fig. 19, B) of great refractive power. The whole was in a very liquid state, and spermatozoa were arranged singly above the threads.

* This suggests one of the causes of the development of the abdominal and thoracic stridulating organs in certain species. See Journ. Linn. Soc., Zool., "On supposed Stridulating Organs of *Steatoda guttata*, Wider.," p. 152, vol. xv.

Immediately after the spider was secured, one of its palpi was removed. The vesiculum seminis was charged with spermatozoa even to the embolos (figs. 1, 2, 3, and 4, E), where they were plainly seen at intervals (fig. 4, *Spe*). I could not, however, discover any on the external parts of the palpus.

I have been unable to gather from the accounts of other species any idea of the motion of the palpi in collecting the semen, except that in some cases they were alternately applied. The large spoon-shaped cavity of the palpi (figs. 1 and 2, A) of *Tegenaria Guyonii* renders this point of interest. These organs were placed *under* the silken sheet; and their movements were like those of a hand under a network striving to secure any substance which was there by causing it to fall through the meshes. It seemed as if the semen were being shaken into the cavity A previous to its collection by the embolos, the concave spatulated opening of which (figs. 3 and 4) is well adapted for the entrance*.

The Pairing.—This species, according to Blackwell (= *T. domestica*, Blackw., British Spiders, p. 164) and Simon (= *T. parietina*, Frc., 'Les Arachnides de France,' vol. ii. p. 61), pair in May. It is of course possible that broods may overlap each other, or that locality may alter the season; but if I may judge from the number of individuals which arrive at maturity in this neighbourhood during July and August, the comparative frequency of wandering males in that period and their scarcity in May, I must call the end of summer the height of the breeding-season. The eggs are laid the following spring.

I observed thirteen couples pairing in confinement from the middle of July to the end of August; and the following account may be taken as typical of the species, with this exception, that the union does not necessarily occur so quickly after the female has gained maturity.

On the 13th of August I placed together a male and a female. On the 17th the latter cast her last skin. Up to that time, 6 A.M., they had taken no notice of one another. At 9.45 P.M. the two were so close together that the femora of the first pair of legs of each were almost in contact. After a few convulsive twitches of the legs, the male pressed forwards, moving his palpi

* Menge ('Preussische Spinnen,' p. 25) has seen, in the cases of *Linyphia*, *Agalena*, *Lycosa*, the semen collected from the sheet by structures analogous to the cavity A, and called by him the spermophorum.

up and down, when, as they touched the palpi of the female, the pair played with these organs like two friendly bees with their antennæ. After a few minutes the female raised herself, leaning a little on her left side, and the male crept forward until his head was under the sternum of his mate, while his first pair of legs were resting upon hers. He now advanced his right palpus, leaning a little to the left and using the left palpus as part of his support. The right palpus was slightly twisted so as to bring the surface drawn in fig. 1 opposite the sexual organ of the female, while the joints below the humeral were directed obliquely outwards and downwards. The digital joint seemed to lie in such a position that, if moved upwards and forwards, the groove G (figs. 1 and 2) would come in contact with the right bursa copulatrix, E*, fig. 21. I have but little doubt that the embolos was by this time transferred from its usual resting-place along the rim of the cavity A to the groove G (figs. 1 and 2). The male now rapidly raised his palpus up and down for four or more seconds, and with such energy as to compel the female to assume a vertical position. He then retired, and again approached her, repeating the movements to a greater or less number, occasionally pausing before he withdrew his palpus with a slight twist inwards. At times he would leave the female for five minutes, and strut with straightened legs round the vase wagging his abdomen. Now and then he would remain perfectly still with the palpus withdrawn, or play with the palpi of the female while she seemed in a comatose state. He would then renew the union with undiminished vigour, appearing on each occasion less desirous of changing his position. I left them at 12.30 A.M. and returned at 7 A.M. The male was still using his right palpus. I saw no application of the left palpus, but have no doubt that it was employed during the night as in other cases. I have not observed the pairing ever interrupted by a fresh collection of semen, although there is no reason to think that this may not occur. The duration of the pairing is long; but I am inclined to think it is more dependent on the difficulty in inserting the embolos than on sexual endurance. The impregnation appeared to take place when the male retained his palpus in front of the bursæ copulatrices for about thirty seconds, which was frequently the case. Ausserer, in describing the pairing of *Epeira diadema* ('Zeitschrift des Ferdinandeums,' Dritte Folge, pt. xiii. 1867, p. 199), seems to confirm this; for he remarks that the male was only a second by the female, but adds :—"Ich glaube kaum dass da der Same in die Samentaschen des Weibchens gelangen könnte, wesshalb ich diesen Vorgang als blöses Vorspiel zur eigentlichen Begattung betrachte." In order to be sure that I had witnessed the absolute coupling, I examined two females which had cast their skin thrice in confinement, and had afterwards consorted with the male as above related. The spermatheca were charged with spermatozoa, but were not so full as if a few weeks had elapsed after their impregnation.

General Remarks.—The sedentary habits of these spiders (*Tegenaria Guyonii*) render them well suited for confinement; but their general avoidance of light is not favourable to observation. The males are the least susceptible in this respect; and their wandering habits may be the cause. Females will resort to the darkest corners of a shaded square glass case. I exposed to the light one of this sex in such a vessel 10 inches square and 6 inches high. She lined each side of her prison with sheets of silk, as if she had attempted to darken it.

With a view to better examination, I have several times moved to sunlight a pairing couple; but the female would resist the continued addresses of the male until again in shade, and on the gradual admission of light she would retire.

The sudden disappearance of the males of many species lead to the conclusion that they die shortly after the fulfilment of their sexual destiny. Such is not the case with *Tegenaria Guyonii*; for I have seen one male in union with three females during twenty days in August. He was healthy in December when killed for dissection. The males are, however, rarely procurable in winter; but this cannot be said of the other sex. It would therefore appear that either the females are more numerous during the breeding-season, or that the males are shorter lived. Darwin ('Descent of Man,' p. 255, 2nd ed.) states that he was informed by Blackwell that males are more numerous than females with a few species, but that in several species out of six genera the reverse appears to be the case. He also refers ('Descent of Man') to Thorell ('On European Spiders,' p. 205) "speaking as if female spiders were generally commoner than males;" but the context of the passage shows that Thorell was alluding to the difficulty of obtaining mature males of all species, and the consequent objection to basing specific distinction on their palpi. The only data I have are not sufficient to form a conclusion as to the *T. Guyonii*; but out of ten young ones caught in July and August, seven now show the swollen palpi of an immature male.

On a few occasions during the pairing-season I have found a male on the top of a cob on which was a recently cast exuvium, while the owner, an immature female, had retreated below. In one case the semen was protruding from the abdominal sexual organ of the male. Thinking that some light might be thrown on the probable case of parthenogenesis in this species (Journ. Linn. Soc., Zool. vol. xvi. p. 536), I removed the pair to separate vases, and after a few days put them together. The male at once (Aug. 19th, 10 A.M.) began to pay his addresses. Shortly afterwards he rapidly applied one of his palpi to the female in the manner already described, and apparently with her consent. At 3 P.M. he charged her, tore away two legs below the trochanter and began to suck one, using the mandibles to hold the limb just as a human being would a stick of asparagus. The female died an hour afterwards. The sexual parts were much deranged, and the opening of the oviduct exposed; but she required another moult to be mature. Fig. 23 represents the state of the undeveloped bursæ copulatrices* denuded of hairs. There were no more chitinous parts than those coloured red. The prolongations (fig. 21, C B*, C B) of the chitinous plate, which in the mature stage pass forwards to the spermatheca, were only represented by a narrow fold of skin; while the spermatheca were but recognizable as small cones without any convolutions about a fourth of the mature length. I carefully examined for spermatozoa, but could find none. I have now in confinement two females which, when in a similar immature stage, were placed with males; but the season has not arrived for knowing the result. In neither case did I observe anything but a very laggard courtship on the part of the males.

Wishing to see how the males would act, I placed three of them on different occasions in a glass vase in which were only a cob and a recently cast exuvium of a female in its natural position. It was interesting to see them searching for something as soon as they felt the threads. Having found the exuvium, they cautiously felt below the web with their legs, as if to see whether

* The female sexual organ, immediately after maturity, is not so chitinous as fig. 21, and somewhat resembles fig. 23; but all the parts are developed, which was not the case with the above spider.

the former occupant was at home. They would then walk away a few inches only to turn back with obstinate repetition, to satisfy themselves after a closer search that they were not mistaken. These spiders, like many others, usually remove their recently cast skin from a web they continue to inhabit almost as soon as their strength enables them; so that the males were justified in thinking that the exuvium indicated the presence of another spider.

The case just mentioned of a male killing an immature female cannot be explained by her supposed sexual incapability. I have seen two males similarly dismember their spouses an hour or so after impregnation*. Hunger could not have been the cause; for all were well fed. One of them partook of a daddy-long-legs and two blowflies during the thirty-six hours previous to his attack. In fact males† in confinement take their food much better than females; and this may be due to their being accustomed to feed during their sexual excursions in places which are strange to them. I have only twice seen a female *Tegenaria Guyonii* drive away the male, and in each case immediately after union, as has often been related of many species. On the other hand, I have kept an adult pair together from the 22nd of August to the 28th of October, and they lived in perfect amity. The male never ceased paying unrequited attentions except to feed. One male was so ferocious that I had immediately to remove on different occasions two young adult females which I had placed with him.

These cases are interesting, inasmuch as they are the converse of authenticated accounts of females of other species attacking the male immediately after his caresses. I have never considered this action otherwise than one to be expected from a creature without gregarious habits, and which must regard weaker forms of animal life as food, or as an inconvenience, if we except its young or its mate when in the act of pairing. Those instincts, which are habitually practised throughout the far greater portion of the life of the species, and on which its existence depends, would

* In all these cases there was no regular cobweb, but only a silken sheet spun at the bottom of the vase.

† They appear to require an occasional drop of water in the vessel which confines them. I have not seen them touch it; and suppose a damp atmosphere is needed. For an account of a female drinking, see Journ. Linn. Soc., Zool., vol. xvi. p. 537.

scarcely be suspended for a longer period than necessary for the sexual union. Spiders frequently eat one another; and such an occurrence after pairing is only curious if considered apart from their habits. When the sexual desire is satiated, their actions would be again directed by the dominant instinct of destruction, which would be stronger if a general excitement be supposed to follow the union.

The excellent means which spiders such as *T. Guyonii* possess of measuring each other's strength when on the same web by the tension and motion of the threads, are calculated to prevent an attack except by the stronger or through blind fury. Now the comparative size of the sexes of this species varies considerably *. It is not unusual to find a large male, with its longer legs, much more formidable in appearance than a small female of recent maturity; and such was the case in the three attacks on the female and in the lengthened courtship above mentioned.

The same caution or, one might say, self-restraint shown by spiders in hesitating before springing on a hopelessly entangled defenceless insect larger than their usual prey, seems equally displayed in conflicts between themselves. Blind fury is not therefore always the actuating impulse.

It will be observed that the attack, when made by a female, often follows the union immediately, while that of the three males took place some time afterwards. The explanation appears to be this:—The action of a female when satiated would be precipitated by the threatened and unacceptable continued application of the hard spiny palpus, while the more lasting desire of the male would have to subside before he became directed by another

* Simon ('Les Arachnides de France,' vol. ii. pp. 60 & 61) gives the following measurements:—

♂. Ceph., length 8·5 mm., breadth 7; legs, 1st 74·5, 2nd 63·6, 3rd 45, 4th 58·2.

♀. Ceph., length 8 mm., breadth 6; legs, 1st 46, 2nd 40·2, 3rd 36, 4th 44. Abd., long. 11, larg. 8.

♂ min. Ceph. long. 4·5; ♀ min., long. 6.

The wandering sexual excursions of the males may have developed the greater length of legs, while the necessary additional weight of the abdomen of females must have affected the cause and sum of natural selection in this respect. The ordinary habits are the same with both sexes.

The sexual excursions of the *Argyronetica aquatica* may have been a larger factor in the development of the greater size of the male as compared with the female. The passage *through* water, which is the habitat, would require more strength than on land.

instinct. By that time, when in a free state, other attractions, if not his wandering disposition, would take him away from the web. Even if he again approached her, and she were the weaker, there would be ample opportunity for an escape by the lower tube of her cob, as collectors know to their loss. So long as the females are not injured, the benefits to the species, both in size and strength, are obvious when males capable of effecting more than one impregnation are sufficiently powerful to prevent an attack.

The Rev. O. P. Cambridge (Proc. Zool. Soc. 1871, p. 621, see also 'Descent of Man,' p. 273, 2nd ed.) ascribes the extreme smallness of the male in the genus *Nephila* to the chances of escape from the female being in favour of a diminutive race of males. This at first sight appears antagonistic to the opinions I have advanced; but natural selection will have effected different degrees of correlation between agility and size according to the habits and early form of the species.

Our Secretary Mr. Romanes ('Animal Intelligence,' p. 205) has referred to these sexual conflicts, and suggests the courage and determination required of the male may be of benefit to the species by instilling these qualities into his descendants. I would add that the capture or escape after union of males capable of effecting more than one impregnation would develop agility and strength; for those which were *maladroit* or weak would be eliminated. The attack by the female would also be of specific advantage, for it is but another form of that vigour which is so profitably directed against the larger kinds of prey.

Certain Organs in the Male Abdominal Sexual Region.

The external abdominal sexual region is marked by a slight convexity, in front of which is placed transversely a row of transparent spines (fig. 7, S S). Two papilla-like processes are situated just above the opening of the ejaculatory duct* (fig. 7, P, P*). Neither of these organs have hitherto been noticed.

* Each vas deferens opens into a sinus which passes backwards and downwards, and unites with its fellow to form a common chamber in front of the groove traversing the ventral surface of the abdomen between the openings of the pulmonary sacs. The chamber opens out on the anterior portion of the groove in a transverse slit. Fig. 6 represents diagrammatically, in section, the position and course of the vas deferens, sinus, and opening. The incomplete function the chamber which unites the two sinuses, as compared with that of other homologous male sexual organs, seems to render the word penis inapplicable to it. I propose to employ the term ejaculatory duct to the chamber.

The *spines* are tubular, point backwards, and project just beyond the convexity. They generally are twenty-four in number, and are placed singly or in groups of two, three, or four. A basin of varied form surrounds each group or single spine (fig. 8, A*, B, C, D). A tube runs from each spine, and, after making many and sudden convolutions, ends in a gland of a pear-shaped form. Figs. 9, 10, 12, 13, and 14 represent different sections from about the spines to the ejaculatory duct, E d, passing through several glands and their ducts. Fig. 11 shows a gland with its duct separated from its spine. The contents of the glands have a high refractive power.

The *papillæ* are erectile, and consist of pointed scales surrounding a fascicule of fibres which internally diverge, and (so far as I have been enabled to follow them) are lost in the connective tissue lining the inferior side of the genital sinus. The points of the scales rest on one another, thus giving to the processes a conical form. The position of one papilla with the scales open, P, is seen in fig. 16; and fig. 17 (osmic-acid preparation) shows the internal direction of the fibres. Fig. 15 represents a papilla after having been submitted to pressure in glycerine. In fig. 18 the scales and external portions of the fibres have been removed, and the papilla is drawn *in situ*, as observed when the spider is on its back, the point of view being from behind along the abdomen.

The question arises as to the function of these glands and papillæ. Their position denotes some share in the primary sexual process. They are not found in the females. I have only met with the papillæ (possibly not fully developed) in immature males, during the stage preceding the last ecdysis, when there are no tubular spines. As to the papillæ, I would suggest that their fibres when protruded are used for arranging or supporting the triangular sheet, or for assisting the collection of semen by the palpi. They are conspicuous on the allied species *Tegeneria atrica* and *T. civilis*. It is more easy to limit the conjectures as to the purpose of the glands to two alternatives:—(1) To pour their secretion on the semen when deposited; or (2) to spin threads which would guide the semen to the silken sheet of which they might form a part. The position of these glands is interesting, for it approximates that of the spinning-

* The bifid form of A seems to show it to be a union of two spines. Only one point was perforated. This is exceptional.

organs of the *Chernetes* (Pseudo-Scorpiones). They are also found, with some modification of arrangement, on *T. atrica*, *T. civilis*, *Epeira diadema*, *Amaurobius fenestralis*, and *A. similis*.

I desire particularly to call to these glands the attention of those interested in the anatomy and study of spiders generally. It yet remains to be observed whether they occur in both sexes in other genera, and whether they only are developed in the adult males of other species.

DESCRIPTION OF THE PLATES.

Plate VII.

Fig. 1. Digital joint of right palpus of *Tegenaria Guyonii*, ♂ (hairs removed). S, sheath; Sp, spermophorum; A, spoon-shaped cavity; G, groove; E, embolos; R s, ribbed surface; T, tentaculum, which is probably used for holding the female. × 15.

2. Spermophorum, embolos, and tentaculum. (Letters as above.) × 40.
3. Opening of embolos. × 255.
4. Opening of embolos: *Spe*, spermatozoa. × 150.
5. Junction of testis with vas deferens.
6. Diagrammatic longitudinal section of male abdominal sexual organ. E d, ejaculatory duct; P, papilla-like process; S S, tubular spines.
7. View from below of male abdominal sexual organ (somewhat diagrammatic). × 80.
8. A, bifid spine and basin; B, two spines with common basin in section; C, common basin of four spines (cut short); D, single spine (cut short) and basin. × 220.
9. Vertical transverse section of male abdominal sexual organ through spines and ejaculatory duct. S S, tubular spines; C, the convoluted ducts; G, G, G, glands; E d, ejaculatory duct; *Spe*, spermatozoa. × 80.
10. Section as above, showing base of spines, convoluted ducts, and G, G* two glands. × 250.
11. Gland and duct leading to one of four spines with common base. The gland was torn on removal of connective tissue. × 250.
12. Vertical longitudinal section of male abdominal sexual organ. A, A, connective tissue traversing glandular region; B, B, connective tissue surrounding the glandular region; G, G*, G*, glands; P, papilla-like process; E d, ejaculatory duct; A M, one of the diverging groups of muscles which run from the external skin to the inferior side of the ejaculatory duct; D, part of a muscle in connexion with the ejaculatory duct. × 75.

Plate VIII.

13. Vertical transverse section. V S, ventral surface; A M, group of diverging muscles which run from external skin to the inferior side of the

ejaculatory duct E d; F, F*, the attachments of two muscles with the external skin a little in front of the ejaculatory duct. The muscles run backwards to the inner corner of each opening of pulmonary sac. × 75.

Fig. 14. Vertical longitudinal section of muscles A M. V S, ventral surface; G, glands. × 75.

15. Papilla after pressure in glycerine. The fibres project. × 570.
16. Right papilla, as viewed from below. The scales are open, P. × 570.
17. Vertical longitudinal section of papilla and fibres. × 570.
18. Right papilla, with scales and external portion of fibres removed. The Spider has been turned on its back, and the view is taken from behind along the abdomen. × 570.
19. Spermatozoa on the silken sheet: A, the border of the sheet. × 570.
20. Sheet on which spermatozoa were deposited, natural size. (Deranged.)
21. Bursæ copulatrices of female *T. Guyonii* (hairs removed). B, chitinous band; C B, C B*, prolongations of band leading to spermatheca; C, thin skin; E and E*, entrances to spermatheca. × 15.
22. Bursæ copulatrices of female *T. Guyonii* (hairs removed). The muscles &c. have been removed to show position of spermathecæ. Letters as above, the arrows point to the entrances of the spermathecæ. × 40.
23. Sexual organ of immature female *T. Guyonii* referred to on p.168. ×15.
24. Vertical longitudinal section of muscle F,F* (fig. 13), showing the fibres *f* which cause the depression on each side of the convexity of abdominal sexual region, ♂. V S, ventral surface.

On the Constancy of Insects in their Visits to Flowers.

By Alfred W. Bennett, M.A., B.Sc., F.L.S.

[Read March 1, 1883.]

A very large amount of attention has been paid during recent years to the habits of insects in visiting flowers with reference to the fertilization of the latter. One point, evidently of importance, seems to require further elucidation, viz. the extent to which, on the same visit, insects confine their visits to the same plant-species. I know of no modern recorded observations which either confirm or refute the statement made by Aristotle:—"During each flight the Bee does not settle upon flowers of different kinds, but flies, as it were, from violet to violet, and touches no other species till it returns to the hive"*.

In my own observations, which require to be supplemented by other independent ones, I chose in all cases as points of observation spots where a considerable number of different flowers grew in profusion and intermixed, so that the insects had abundant opportunity of changing their diet if so disposed. In recording the number of flowers of the same kind visited by an insect in the same flight, I always mean flowers at such a distance from one another that the insect has had to use its wings in getting to each. Wherever the flowers grew in so close an inflorescence that it could crawl from one flower to another without using its wings, as in the Compositæ, Dipsacaceæ, and Umbelliferæ, the clovers, and many Labiatæ, such an inflorescence is here treated as a single flower. I have thought it best to record briefly every observation made on the subject, in order that there may be no suspicion of their having been chosen for a special object.

Obs. 1. Near Ross, Herefordshire, Aug. 3rd, 1880. Flowers growing close together:—*Rubus fruticosus*, *Senecio Jacobæa*, *Hypericum perforatum*, *H. montanum*, *Erythræa Centaurium*, *Trifolium procumbens*, *Calamintha Clinopodium*, *Malva moschata*, *Arctium Lappa*, *Teucrium Scorodonia*, *Torilis Anthriscus*. The Meadow-brown Butterfly (Hipparchia Janira) visited the bramble alone 7 times in succession.

* Aristotle, 'History of Animals,' Book ix. cap. 27, sect. 7 (Bohn's translation).

2. Near Ross, Herefordshire, Aug. 3rd, 1880. Hipparchia Janira: *Senecio Jacobæa*, 2 visits; *Hypericum perforatum*, 1.

3. ——*. ——*: *Senecio Jacobæa*, 4 times; *Leontodon autumnalis*, 1.

4. ——. Bombus sp.: *Malva moschata* only, 15 visits.

5. ——. ——: *Malva moschata* only, 11 visits. In both the last cases a number of different flowers were passed over in the intervals of alighting on the flowers of the mallow.

6. ——. ——: *Arctium Lappa*, 7; *Rubus fruticosus*, 6; distinctly refusing *Senecio Jacobæa* when intermixed with them.

7. Near Tenby, Aug. 11th, 1880. *Senecio Jacobæa, Lotus corniculatus, Centaurea Scabiosa, C. nigra, Daucus Carota, Ononis arvensis, Galium verum, Achillæa Millefolium, Echium vulgare, Convolvulus arvensis, Salvia Verbenaca.* The small Tortoise-shell Butterfly (Vanessa Urticæ) lighted many times on *Senecio Jacobæa*, passing over many other flowers, and covering in its flight a considerable area.

8. ——. Bombus sp.: *Centaurea Scabiosa* only, 8 visits.

9. ——. ——: *Centaurea nigra* only, 7.

10. ——. ——: *Ononis arvensis*, 14 times; *Convolvulus arvensis*, 2; *Ononis arvensis* again, 1; *Lotus corniculatus*, 2.

11. ——, Aug. 12th, 1880. *Centaurea Scabiosa, C. nigra, Senecio Jacobæa, Trifolium pratense, Armeria vulgaris, Scabiosa succisa, Daucus Carota, Achillæa Millefolium, Pimpinella Saxifraga, Convolvulus arvensis, Stachys Betonica.* The Painted Lady Butterfly (Cynthia Cardui) visited *Centaurea nigra* 5 times; *C. Scabiosa*, 1.

12. ——. Cynthia Cardui: *Centaurea Scabiosa*, 1; *C. nigra*, 2.

13. ——. ——: *C. nigra*, 2; *C. Scabiosa*, 1; *C. nigra*, 6; *C. Scabiosa*, 1. This Butterfly, of which considerable numbers were seen, appeared to confine its attention entirely to the two species of knapweed, though frequently making long flights between each settlement, and apparently passing indifferently from one of these species to the other.

14. ——. Bee (Apis mellifica): *Scabiosa succisa*, 1 visit; *Centaurea Scabiosa*, 9; passing over many other species.

15. Manorbeer, Pembrokeshire, Aug. 23rd, 1880. *Scabiosa arvensis, Centaurea nigra, C. Scabiosa, Agrimonia Eupatoria, Pru-*

* To save space and repetition of names short lines have been introduced, the one referring to the place, the other to the insect—viz. the same as that preceding where mentioned in full.

nella vulgaris, Crepis virens, Achillea Millefolium, Stachys Betonica, Daucus Carota, Chrysanthemum Leucanthemum, Trifolium pratense. The Large White Butterfly (Pieris Brassicæ) visited *Centaurea nigra* 3 times ; *Stachys Betonica*, 1.

16. Manorbeer, Pembrokeshire, Aug. 23rd, 1880. The common Blue Butterfly (Polyommatus Alexis): *Stachys Betonica*, 1 ; *Trifolium pratense*, 1 ; *Lotus corniculatus*, 1 ; *Anthyllis Vulneraria*, 1 ; *Centaurea nigra*, 1 ; *Lotus corniculatus*, 1.

17. ——. The small White Butterfly (Pieris Rapæ): *Scabiosa arvensis*, 1 ; *Centaurea nigra*, 7; *Prunella vulgaris*, 1 ; *Centaurea nigra*, 1 ; *Prunella vulgaris*, 1 ; *Centaurea nigra*, 3.

18. ——. ——: *Scabiosa arvensis*, 2 ; *Centaurea nigra*, 6.

19. ——. Bee (Apis mellifica): *Centaurea nigra*, 4 visits ; passing over many other flowers.

20. ——, Aug. 24th, 1880. *Centaurea nigra, Daucus Carota, Convolvulus arvensis, Euphrasia officinalis, Senecio Jacobæa, Leontodon autumnalis, Lotus corniculatus, Spiranthes autumnalis, Agrimonia Eupatoria, Rubus fruticosus, Eupatorium cannabinum, Potentilla reptans.* Bombus sp. visited *Centaurea nigra* 13 times in succession, travelling considerable distances.

21. ——. Polyommatus Alexis settled twice on *Lotus corniculatus* at a considerable distance apart, arresting its flight over, but never settling on, other yellow flowers.

22. ——, Aug. 24th, 1880. *Trifolium pratense, Convolvulus arvensis, Bartsia Odontites, Cerastium glomeratum, Centaurea nigra, Rubus fruticosus, Prunella vulgaris, Lotus corniculatus.* Syrphus clypeata: *Convolvulus arvensis*, 2; *Cerastium glomeratum*, 3 ; *Convolvulus arvensis*, 5 ; *Cerastium glomeratum*, 1 ; *Convolvulus arvensis*, 1. When driven away, always returning to the bindweed.

23. ——. Pieris Rapæ: *Bartsia Odontites*, 7; *Centaurea nigra*, 1 ; *Bartsia Odentites*, 1.

24. ——. Polyommatus Alexis: *Lotus corniculatus*, 2 ; precisely repeating no. 21.

25. Kew, May 14th, 1881. *Nepeta Glechoma, Ranunculus bulbosus, Taraxacum officinale, Lamium album, Pyrus Malus.* Bombus sp. was seen to visit the ground-ivy 93 times in succession, without touching any other flower.

26. ——. Bombus sp.: Visited the ground-ivy 25 times in succession, without touching any other flower.

27. ——. ——: *Taraxacum officinale, Pyrus Malus, Cardamine pratensis, Bellis perennis, Plantago lanceolata, Anthriscus*

sylvestris, *Rumex acetosa*, *Saxifraga granulata*. Confined its attention entirely to the dandelion; but the number of visits was not counted.

28. KEW, May 14th, 1881. Apis mellifica: The apple 5, without visiting any other flower.

29. ——. Bombus sp.: *Pyrus Malus* only, 14.

30. "THE KNOLL," AMBLESIDE, Aug. 5th, 1881. *Melampyrum pratense*, *Hypericum pulchrum*, *Stachys Betonica*, *Potentilla Tormentilla*, *Spiræa Ulmaria*, *Rubus fruticosus*. Bombus sp.: *Melampyrum pratense* only, 9 visits.

31. ——. Bombus sp.: *Stachys Betonica* only, 6 visits. This Bee was captured and the pollen on its hind legs examined under the microscope. It was to all appearance of one kind only, corresponding to that of *Stachys Betonica*.

32. ——. ——: *Stachys Betonica*, 6.

33. ——. ——: *Stachys Betonica*, 10.

34. ——. ——: *Stachys Betonica*, 6.

35. ——. ——: *Stachys Betonica*, 10.

36. ——. Syrphus clypeata: *Potentilla Tormentilla*, 8.

37. LOW WOOD, WINDERMERE, Aug. 11th, 1881. *Centaurea nigra*, *Serratula tinctoria*, *Spiræa Ulmaria*, *Geranium sylvaticum*, *Poterium officinale*, *Achillæa Ptarmica*, *Campanula rotundifolia*, *Linaria vulgaris*, *Euphrasia officinalis*, *Stachys Betonica*, *S. palustris*, *Lythrum Salicaria*. Bombus sp.: *Stachys palustris*, 2; *Centaurea nigra*, 2.

38. ——. Bombus sp.: *Centaurea nigra*, 1; *Serratula tinctoria*, 3; *Centaurea nigra*, 12.

39. ——. ——: *Stachys Betonica*, 3; *Centaurea nigra*, 1.

40. ——. ——: *Serratula tinctoria*, 2.

41. ——. ——: *Centaurea nigra*, 12; *Serratula tinctoria*, 3; *Centaurea nigra*, 3. This Bee confined its attention to these two species, although passing over a large number of other flowers.

42. ——, Aug. 12th, 1881. Pieris Rapæ, ♂: *Geranium sylvaticum*, 2; *Centaurea nigra*, 2, at a great distance from one another; *Achillæa Ptarmica*, 1.

43. ——. ——: *Stachys Betonica*, 11, passing over all other flowers.

44. ——. ——: *Stachys Betonica*, 20, obviously rejecting both the *Centaurea* and *Serratula*. These two last Bees were both captured and the pollen attached to their legs examined, when it was again found to be all of one kind, corresponding

to that of the betony, elliptical, smooth, with longitudinal furrows.

45. Low Wood, Windermere, Aug. 12th, 1881. Apis mellifica: *Serratula tinctoria* only, 24, constantly rejecting *Centaurea nigra.* This Bee was also captured and the pollen adhering to its legs examined. It proved to consist entirely, or nearly so, of the pollen of the *Serratula*, which is very characteristic, white, shortly oval, with blunt spines; while that of the *Centaurea nigra* has a smooth extine.

46. ——. Eristalis tenax: *Centaurea nigra*, 1; *Spiræa Ulmaria*, 2; *Centaurea nigra*, 2.

47. ——. ——: *Centaurea nigra*, 1; *Serratula tinctoria*, 2; *Stachys Betonica*, 1; *Serratula tinctoria*, 1.

48. ——. Pieris Rapæ, ♂: *Achillea Ptarmica*, 1; *Serratula tinctoria*, 1; *Spiræa Ulmaria*, 1.

49. ——. ——: *Serratula tinctoria*, 1; *Centaurea nigra*, 4; constantly settling meanwhile on leaves.

50. ——. ——: *Stachys palustris* only, 23.

51. The Ferry, Windermere, Aug. 15th, 1881. *Spiræa Ulmaria, Centaurea nigra, Lythrum Salicaria, Prunella vulgaris, Thalictrum flavum, Valeriana officinalis, Lychnis flos-cuculi, Stachys palustris, Scabiosa succisa.* Bombus sp.: *Scabiosa succisa*, 1; *Lythrum Salicaria*, 5; *Prunella vulgaris*, 1; *Lythrum Salicaria*, 1.

52. ——. Bombus sp.: *Centaurea nigra*, 1; *Scabiosa succisa*, 5; *Valeriana officinalis*, 1; *Centaurea nigra*, 2.

53. ——. ——: *Stachys palustris*, 3, at great distances from one another.

54. ——. ——: *Lythrum Salicaria*, 4, at great distances from one another.

55. ——. Syrphus clypeata: *Spiræa Ulmaria*, 6; *Valeriana officinalis*, 1; when removed from the meadowsweet, always returning to it.

56. "The Knoll," Ambleside. *Rubus fruticosus, Stachys Betonica, Achillæa Millefolium, Campanula rotundifolia, Teucrium Scorodonia, Hypericum humifusum, Rumex Acetosella, Centaurea nigra.* Apis mellifica abundantly visiting the bramble, and when disturbed always returning to it, obviously declining *Achillæa Millefolium* and *Stachys Betonica.*

57. ——. Eristalis tenax was visiting *Achillæa Millefolium* only. This was captured, and the contents of its abdomen exa-

mined under the microscope. It was found to consist of an enormous quantity of pollen-grains, of which by far the larger part corresponded to that of the milfoil—small, bright yellow, nearly spherical, and spined. This was mixed with a much smaller quantity of two other kinds; one was not recognized; the other, of which there were only a few grains, was apparently that of *Epilobium montanum*, a plant not growing in the immediate vicinity.

58. "The Knoll," Ambleside. Syrphus clypeata passed indifferently from *Achillæa Millefolium* to *Stachys Betonica*. The mass of pollen-grains in its abdomen, examined in the same way, appeared to be of two kinds only, corresponding to the pollen of these two plants.

59. ——. Pieris Rapæ, ♀ : *Rubus fruticosus*, 1; *Achillæa Millefolium*, 2.

60. ——. Bombus sp.: *Rubus fruticosus*, 2; *Stachys Betonica*, 1; *Rubus fruticosus*, 2; *Teucrium Scorodonia*, 7.

61. ——, Aug. 21st, 1881. *Potentilla Tormentilla*, *Melampyrum pratense*, *Hieracium sylvaticum*, *Solidago virgaurea*, *Calluna vulgaris*, *Galeopsis Tetrahit*, *Rubus fruticosus*, *Geranium Robertianum*, *Stachys Betonica*. A small Wood-Bee visited *Potentilla Tormentilla* only; the pollen on its legs was examined, and appeared to belong to that flower exclusively.

62. ——. Bombus sp.: *Rubus fruticosus*, *Galeopsis Tetrahit* (white), *Corydalis claviculata*, growing completely intermixed. Several Humble-Bees belonging to different species confined their visits entirely to the bramble.

63. Conishead Priory, near Ulverston, Aug. 22nd, 1881. *Heracleum Sphondylium*, in great profusion, both white and pink, intermixed with smaller quantities of *Centaurea nigra*, *Trifolium pratense*, and *Senecio Jacobæa*. Large numbers of Eristalis tenax were hovering and settling on the *Heracleum Sphondylium*, irrespective of colour, and on nothing else. The abdomen of two specimens captured was loaded with the pollen of this flower only.

64. ——. Bombus sp. visiting *Centaurea nigra* only, refusing *Trifolium pratense*.

65. ——. ——. Visiting both *Centaurea nigra* and *Trifolium pratense*.

66. ——. ——. Was watched visiting foxgloves, *Digitalis purpurea*, of which there were about an equal number, white and pink. It entered 16 flowers in succession, without visiting any

other species meanwhile (although to find them it had to fly considerable distances), and these were indifferently white and pink.

The 66 observations above recorded refer to three orders only of insects,—the Rhopalocera among Lepidoptera, the Syrphidæ among Diptera, and the Apidæ among Hymenoptera. As far as they go, they would appear to indicate very different degrees of constancy in regard to the species of flowers visited in the different groups.

The 18 observations on Butterflies refer to 6 species:—*Pieris Brassicæ* and *P. Rapæ*, *Polyommatus Alexis*, *Cynthia Cardui*, *Hipparchia Janira*, and *Vanessa Urticæ*. Of these, the two Whites and the Blue (Obs. nos. 15, 16, 17, 18, 21, 23, 24, 42, 48, 49, 59) appear to visit different species of flowers in succession without scruple, and in several cases quite regardless of colour, the *Alexis* paying in one instance 5 successive visits to 5 different flowers of different colours. But in two other cases the same Butterfly showed a marked preference for *Lotus corniculatus*, and was attracted also by other yellow flowers. *Vanessa Urticæ* was observed only once (Obs. no. 7), and then confining its visits to *Senecio Jacobæa*. Three observations (Nos. 1, 2, 3) were made on *Janira*: in one instance it was visiting the bramble only; in the two others two different flowers, all yellow. In three observations on *Cynthia Cardui* (Nos. 11, 12, 13) this brilliant Butterfly was confining its attentions entirely to the two common species of *Centaurea*, which it was visiting indifferently. On the whole, Butterflies appear to manifest but a small degree of constancy in visiting flowers; the great majority of those on which they were seen to settle were either yellow or pink; and when beginning with one of these colours, there seemed a marked tendency to adhere to it. From the very long flights of Butterflies, and their constantly settling on foreign objects, such as grass, the trunks of trees, the bare ground, &c., it may be doubted whether they perform nearly so large a part in the fertilization of flowers as other orders of insects.

Of the Syrphidæ or Hover-flies, two species only were the subject of observation, both very common, *Eristalis tenax* and *Syrphus clypeata*. These insects are large consumers of pollen, and therefore in several cases they were captured, and the contents of the abdomen examined, in order, where possible, to recognize the pollen-grains on which they fed. Four observations (Nos. 46, 47, 57, 63) were made on *Eristalis tenax*. In two of them it showed but little constancy; in the third it confined itself to a single flower (*Heracleum Sphondylium*), the flowers of which were both white and pink: and the abdomen was found to be loaded with the pollen of this flower only. In the fourth case it was also visiting a single flower (*Achillæa Millefolium*), and almost the whole of the pollen in the abdomen appeared to be of this kind, intermixed with a few grains of two other species. *Syrphus clypeata* was also observed four times (Nos. 22, 36, 55, 58); in one case only was it constant in its visits to a single flower. The pollen-grains in the abdomen were in one instance examined, and found to consist of two kinds in about equal quantities, belonging to widely separated natural orders, the Compositæ and Labiatæ. Although the Syrphidæ are constantly hovering over and settling on flowers, their function of conveying pollen is probably small compared to that of the Hymenoptera, their object in visiting the flowers being not to carry away the pollen, but to consume it.

By far the majority of my observations (40) were made on the visits of Apidæ, and the greater number of these (33) on various species of *Bombus* or Humble-Bee; and here I regret that ignorance of the specific distinctions in this difficult genus detracts materially from the value of what I observed. In four instances (Nos. 10, 51, 52, 60) was a Humble-Bee observed to visit as many as three distinct species of flower on the same visit, and to a large extent irrespective of colour. In six instances (Nos. 6, 37, 38, 39, 41, 65) the number of species visited while the insect was kept in sight was two; and in all these instances the colour of the two flowers was nearly the same. In twenty-three instances (Nos. 4, 5, 8, 9, 20, 25, 26, 29, 30, 31, 32, 33, 34, 35, 40, 43, 44, 50, 53, 54, 62, 64, 66) the Bee confined itself, while kept within observation, to a single species; but these plants were, in the different instances, of the most various kinds and colours, some shade of pink largely predominating, but we have also blue, yellow, and white. The largest number of consecutive visits observed was—to the apple 14, *Malva moschata* 15, *Stachys Betonica* 20, *Stachys palustris* 23, *Nepeta Glechoma* 25, and, again, *Nepeta Glechoma* (obs. No. 25) as many as 93 consecutive visits. As the details of these observations will show, there can be no doubt about this constancy being purposed, the flowers in question in all cases growing intermixed with others, and the Bee frequently traversing considerable distances in order not to mix its pollen. In two cases (Nos. 31 and 44) the pollen attached to the hind legs was examined, and found to be of one kind only, corresponding to that of the flower on which it was captured. It was quite obvious that at the same spot different Bees of the same species were visiting different flowers. Obs. no. 66 is particularly interesting as showing that the insect, however, is not attracted by colour only. At a spot where there were both white and pink foxgloves, a large Humble-Bee was watched to pay 16 successive visits to the flowers of this plant, indifferently white and purple, passing over in its flights many other kinds of flowers and flying considerable distances.

A single observation (No. 61) was made on an unknown species of Wood-Bee. It was visiting one species only (*Potentilla Tormentilla*) on a woody knoll, where there was a large number of others; the number of separate visits was not counted, but was very large. The pollen on the legs appeared to be of this one kind only.

The common Hive-Bee (*Apis mellifica*) was observed six times (Nos. 14, 19, 27, 28, 45, 56). On one of these occasions only (No. 14) did it visit two different flowers while kept in sight, paying one visit to the blue *Scabiosa succisa*, and then nine in succession to the pink *Centaurea Scabiosa*; in all the others it was absolutely constant to one flower. In four of these instances the flower visited was pink or some shade of red, viz., *Centaurea nigra* 4 visits, the apple 5, *Serratula tinctoria* 24, and the bramble a large number, but not counted. Obs. No. 45 is very interesting. The Bee paid 24 consecutive visits to *Serratula tinctoria*, obviously rejecting *Centaurea nigra*, which is not unlike it in general appearance and nearly the same colour. This individual was captured and the pollen on its legs examined, when it proved to consist entirely, or nearly so, of that of the *Serratula*, which is of a very characteristic form, and very different from that of the *Centaurea*. In the remaining instance (No. 27) the flower visited was yellow, viz. the Dandelion; the number of visits was not counted, but was very large.

In accordance with a plan suggested by my friend Mr. Robert Miller Christy, who has been pursuing the same line of observation in greater detail than I am able to do, and with great success, I append a Table indicating the number of visits paid while the insect was kept under observation in the sixty-six different cases, the number of species among which the visits were distributed, and the colours of the flowers, which I have divided into four groups, viz.:—R, red, pink, or purple; B, blue or violet; Y, yellow or orange; W, white.

The number of observations I have been able to make is probably not sufficient to determine any general law with regard to the constancy of insects in visiting flowers. As far as the results go, they may be stated as follows:—

The different classes of insects show very great difference in this respect. Butterflies show but little constancy, except in a few instances; but they would appear to be guided to a certain extent by a preference for particular colours. The Diptera exhibit greater constancy, though by no means absolute. A much greater degree of constancy is manifested by the Apidæ; and this becomes all but absolute in the Hive-Bee. It is an interesting circumstance that this constancy appears to increase in proportion to the part performed by the insects in carrying pollen from flower to flower. A much larger number of observations is, however, needed in order to determine with certainty any general law; and especially a careful microscopic examination of the pollen attached to the proboscis, mandibles, legs, and underside of the abdomen and thorax.

As regards preference for particular colours, the Lepidoptera paid, while under observation, 70 visits to red or pink flowers, 5 to blue, 15 to yellow, 5 to white; the Diptera 9 to red or pink, 8 to yellow, 20 to white; the Hymenoptera 303 to red or pink, 126 to blue, 11 to yellow, 17 to white.

Lepidoptera.

Obs. No.	Name.	No. of species visited.	No. of visits paid and colour of flower.
15.	Pieris Brassicæ	2	R 3, R 1.
17.	Pieris Rapæ	3	B 1, R 7, B 1, R 1, B 1, R 3.
18.	,,	2	B 2, R 6.
23.	,,	2	R 7, R 1, R 1.
42.	,,	3	R 2, R 2, W 1.
48.	,,	3	W 1, R 1, W 1.
49.	,,	2	R 1, R 4.
59.	,,	2	R 1, W 2.
16.	Polyommatus Alexis	5	R 1, R 1, Y 1, Y 1, R 1, Y 1.
21.	,,	1	Y 2.
24.	,,	1	Y 2.
1.	Hipparchia Janira	1	R 7.
2.	,,	2	Y 2, Y 1.
3.	,,	2	Y 4, Y 1.
7.	Vanessa Urticæ	1	Y (not counted).

Obs. No.	Name.	No. of species visited.	No. of visits paid and colour of flower.
11.	Cynthia Cardui	2	R 5, R 1.
12.	,,	2	R 1, R 2.
13.	,,	2	R 2, R 1, R 6, R 1.

DIPTERA.

46.	Eristalix tenax	2	R 1, W 2, R 2.
47.	,,	3	R 1, R 2, R 1, R 1.
57.	,,	1	W (not counted).
63.	,,	1	R and W (same species, not counted).
22.	Syrphus clypeata	2	W 2, W 3, W 5, W 1, W 1.
36.	,,	1	Y 8.
55.	,,	2	W 6, R 1.
58.	,,	2	W, R (not counted).

HYMENOPTERA.

4.	Bombus sp.	1	R 15.
5.	,,	1	R 11.
6.	,,	2	R 7, R 6.
8.	,,	1	R 8.
9.	,,	1	R 7.
10.	,,	3	R 14, W 2, R 1, Y 2.
20.	,,	1	R 13.
25.	,,	1	B 93.
26.	,,	1	B 25.
29.	,,	1	R 14.
30.	,,	1	Y 9.
31.	,,	1	R 6.
32.	,,	1	R 6.
33.	,,	1	R 10.
34.	,,	1	R 6.
35.	,,	1	R 10.
37.	,,	2	R 2, R 2.
38.	,,	2	R 3, R 12.
39.	,,	2	R 3, R 1.
40.	,,	1	R 2.
41.	,,	2	R 12, R 3, R 3.
43.	,,	1	R 11.
44.	,,	1	R 20.
50.	,,	1	R 23.
51.	,,	3	B 1, R 5, B 1, R 1.
52.	,,	3	R 1, B 5, R 1, R 2.
53.	,,	1	R 3.
54.	,,	1	R 4.
60.	,,	3	R 2, R 1, R 2, W 7.
62.	,,	1	R (not counted).
64.	,,	1	R (not counted).
65.	,,	2	R, R (not counted).
66.	,,	1	R and W 16 (same species).
61.	Wood-bee	1	Y (not counted).
14.	Apis mellifica	2	B 1, R 9.
19.	,,	1	R 4.
27.	,,	1	Y (not counted).
28.	,,	1	R 5.
45.	,,	1	R 24.
56.	,,	1	R (not counted).

On the Methodic Habits of Insects when visiting Flowers. By ROBERT MILLER CHRISTY. (Communicated by ALFRED W. BENNETT, F.L.S.)

[Read March 1, 1883.]

THE following results of a series of observations are laid before the Society, as a factor to assist in the solution of the important, although hitherto somewhat neglected, question as to the extent to which insects confine their visits to one species of flower on one flight.

The perusal, in 1881, of Mr. Bennett's paper "On the Constancy of Insects in their Visits to Flowers"* first led me to pay attention to the matter; and I hope that my altogether independent observations will be found to supplement and corroborate his. Throughout all my observations I have endeavoured to adopt a method of procedure precisely identical with that described by Mr. Bennett. I regret that some of my earlier observations were not made so systematically as the later ones, and that I have been unable to distinguish between nearly all of the various species of Humble-Bee and between some of the species of plants.

Altogether I am able to record the movements of 76 insects whilst engaged in visiting at least 2400 flowers. It is not my intention to lay the details of each observation before the Society: these I hope to publish elsewhere†; but instead, I have been induced to condense the observations in the subjoined tabular form. In some respects this is preferable, as the eye more readily appreciates at a glance and elicits those points whence ultimate conclusions are drawn.

Of the following three Tables, the first relates to the Hive-Bee, the second to all the species of Lepidoptera, and the third to all the species of Humble-Bee which have been under observation. The Tables are all arranged upon one plan. The first column gives the number of the observation, the second the name of the insect, and the third the number of different plant-species which it visited. The next three columns show the number of times the insect visited each species (the highest numbers coming first), and the succeeding column shows the total number of flowers of all species visited whilst the insect was under obser-

* Read before the York Meeting of the British Association, 1881.

† See 'Entomologist,' July 1883, vol. xvi. p. 145.

vation*. The concluding column is intended to make plain the order in which the species were visited, and how many times each was visited consecutively, as well as the colour of their flowers. The colours are represented as follows:—

W=white, Y=yellow, R=red (of various tints), and B=blue.

A glance at these Tables will show plainly that a very decided preference exists among insects for a considerable number of consecutive visits to flowers of the same species.

No one, I think, who takes the trouble to wade through the details will deny that there is apparent in very many, if not in most of them, some powerful influence at work which induces insects, where possible, to continue visiting for a considerable time continuously the flowers of the same species of plant, neglecting meanwhile nearly all other sorts. Of course it is utterly impossible to say (without perhaps a microscopical examination of the pollen a bee brings home) whether one insect on one flight from its hive or nest confines itself exclusively or principally to one species of plant; but, according to my observations, there seems to be great probability of its so doing.

So far as Table I. goes, it will be seen that the Hive-Bee is *perfectly* methodic in its habits; and it seems therefore to follow

TABLE I.—Hive-Bee (*Apis mellifica*).

Number of observation.	Number of species visited.	1st sp.	2nd sp.	3rd sp.	Total number of flowers visited.	Order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.	
21.	1	14	......	......	14	14 Y.	All showing absolute constancy.
22.	1	14	......	......	14	14 Y.	
26.	1	?	......	......	?	? Y.	
29.	1	?	......	......	?	? Y.	
30.	1	23	......	......	23	23 Y.	
32.	1	117	......	......	117	117 Y.	
33.	1	43	......	......	43	43 Y.	
38.	1	47	......	......	47	47 Y.	
8.	8	258			258		

* The totals given in the Tables are not quite correct, as there are in each case certain observations in which the exact number of visits was not counted; and these of course could not be included. In the last column of TableIII. the bracketed "1st" and "2nd" indicate that those visits to which they are attached were to the 1st, 2nd, or 3rd species which the insect visited as the case may be.

TABLE II.—Lepidoptera.

Number of observation.	Name of species.	Number of species visited.	Number of visits to 1st species.	Number of visits to 2nd species.	Number of visits to 3rd species.	Total number of flowers visited.	Showing order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.
24.	*Vanessa urticæ*	1	19	....	....	19	19 Y.
31.	*Gonepteryx rhamni*	1	3	....	....	3	3 Y.
46.	*Argynnis*, ? sp. (small)	1	8	....	....	8	8 copper-coloured.
47.	,, ,,	1	?	....	....	?	?
59.	*Colias*, ? sp.	2	4	2	....	6	2 light Y, ,, 4 Y.
60.	*Argynnis aglaia*	1	10	....	....	10	10 R.
62.	,, ,,	2	3	2	....	5	2 B, 3 R.
67.	Moth, ? sp.	2	2		....	3	2 W, 1 R.
71.	*Parnassius Apollo*	1	4	....	....	4	4 R.
72.	*Lycæna*, ? sp.	1	3	....	....	3	3 Y.
73.	*Argynnis lathonia*	1	27	....	....	27	27 Y.
75.	*Pieris brassicæ*	1	11	....	....	11	1 R, 10 Pink, same species.
12.		15	94	5	....	99	

that this is the most valuable species to plants, and is also probably, on account of its methodic habits, enabled to get through the most work. Both my observations on this point and also Mr. Bennett's lead to almost exactly the same conclusion*. It would be interesting to ascertain whether the Ligurian Bee or Mr. Blow's newly introduced Cyprian Bee, both of which are said to be more productive than our common Hive-Bee, are equally methodic—they could hardly be more so. Eight insects which I watched visited altogether eight species of flowers 258 times, or an average of about 32 flowers each. This species of Bee is so perfectly methodic, that when I have carefully watched (as in observations No. 26 and 29) a number of individuals visiting frequently a variety of different flowers growing together, I have never yet been able to see a Hive-Bee change one species of flower for another; on the contrary, as in my best observation (No. 32), I have often seen flowers of another species, although often of the same colour, obviously rejected.

Table II. (Lepidoptera) shows a considerably greater degree of constancy than it would have done, judging from Mr. Bennett's observations, had I watched a larger number of species. In this class Mr. Bennett and I have, with two exceptions, observed different species. As it is, 12 individuals which I have had under observation have visited 99 flowers belonging to 15 species; but 94 of these flowers belonged to 12 species.

Table III. shows a fairly high degree of constancy or method on the part of the Humble-Bees, as 46 insects, of whose movements I have exact details, visited 1751 flowers belonging to 74 species; but 1605 of these flowers belonged to 46 species, 1733 belonged to 65 species, 1745 belonged to 70 species, and 1750 belonged to 73 species. Taking all my 55 observations together, it will be seen that one insect visited, whilst kept in sight, no less than 5 species of flower, 3 visited 4 species, 4 visited 3 species, 18 visited 2 species, whilst 29 (or rather more than half) visited one species only.

* Since the foregoing was written, however, I have observed a Hive-Bee that was not perfectly methodic. Near Saffron Walden I saw one visit *Anemone nemorosa* 1, *Ranunculus Ficaria* 1, *Anemone nemorosa* 1, and *Ranunculus Ficaria* again once, and was then lost. The only other flower out around was *Primula vulgaris*. This was very early in the spring (April 6th), at which time, as in the autumn, as I now have reason to believe, Bees are less systematic than at other times. The season this year, at the date named, was exceedingly unfavourable for Bees, and very few flowers were out.

TABLE III.—Humble-Bee, *Bombus* (many species).

Number of observation.	Name of species.	Number of species visited.	Number of visits to 1st species.	2nd species.	3rd species.	4th species.	5th species.	Total number of flowers visited.	Showing order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.
1.	*Bombus scrimshiranus*	1	?	......	......	......	......	?	? Y.
2.	*Bombus*, ? sp.	1	?	......	......	......	......	?	? Purple.
3.	,, ...	3	110	13	2	......	......	125	39 R, 2 R, 7, 3, 10, 3, 12, 1, 27, 2, 2, 1, 2, 14 (all red, 1st and 2nd alternately), 2 R (fresh sp.).
4.	,, ...	4	55	51	5	3	......	114	46 R, 6 R, 4 R (1st), 10 R (2nd), 1 R (1st), 5 Y, 4 R (2nd), 2 W, 19 R (2nd), 1 W (4th), 16 R (2nd).
5.	,, ...	1	49	......	......	......	......	49	49 W.
6.	,, ...	1	31	......	......	......	......	31	31 W.
7.	,, ...	2	6	1	......	......	......	7	5 Y, 1 R, 1 Y (1st).
8.	,, ...	2	5	1	......	......	......	6	5 R, 1 Y.
9.	,, ...	1	6	......	......	......	......	6	6 R.
10.	,, ...	5	about 200	5	3	1	1	about 210	22 Y, 1 Y, 34 Y (1st), 16 Y (1st), 1 Y (2nd), 10 Y (1st), ? Y (1st), 1 Y (2nd), 9 Y (1st), 1 R, ? Y (1st), ? Y (1st), 5 R.
11.	,, ...	4	?	?	2	1	......	?	1 B, ? R, 1 Pink, 1 W (2nd), ? B (1st), 2 ?
12.	,, ...	3	?	2	2	......	......	?	2 R, 2 R, ? Bluish.
13.	,, ...	3	?	?	?	......	......	?	? B, ? R, ? B (1st), 1 R.
14.	,, ...	1	58	......	......	......	......	58	58 B.
15.	,, ...	1	15	......	......	......	......	15	15 B.
16.	,, ...	1	15	......	......	......	......	15	15 B.
17.	,, ...	1	41	......	......	......	......	41	41 B.
18.	,, ...	1	13	......	......	......	......	13	13 B.
19.	,, ...	1	32	......	......	......	......	32	32 B.
20.	,, ...	1	57	......	......	......	......	57	57 B.
23.	*Anthrophora acevorum*, Fabr. ...	1	5	......	......	......	......	5	5 Y.
25.	,, ,,	1	108	......	......	......	......	108	108 Y.
27.	*Bombus scrimshiranus*	2	?	?	......	......	......	?	? Y, ? B (both many times alternately).

28.	*Anthrophora acervorum*, Fabr. ...	2	?	?	......	......	......	?	? Y, ? B (both many times alternately).
34.	*Bombus*, ? sp.	2	52	1	......	......	......	53	52 B, 1 B.
35.	,, ...	1	7	......	......	......	......	7	7 R.
36.	,, ...	1	9	......	......	......	......	9	9 R.
37.	,, ...	1	11	......	......	......	......	11	11 R.
39.	,, ...	1	4	......	......	......	......	4	4 Y.
40.	,, ...	2	?	?	......	......	......	?	? W, ? R.
41.	,, ...	2	3	1	......	......	......	4	2 R, 1 Y, 1 R (1st).
42.	,, ...	2	12	11	......	......	......	23	12 R, 11 W (two species of *Trifolium*).
43.	,, ...	1	15	......	......	......	......	15	8 Purple, 2 W, 5 Purple (all *Digitalis purpurea*).
44.	,, ...	1	8	......	......	......	......	8	8 B.
45.	,, ...	1	over 50	......	......	......	......	over 50	Over 50 W.
48.	,, ...	2	?	1	......	......	......	?	? R, ? W (all *Trifolium hybridum*?)
49.	,, ...	1	27	......	......	......	......	27	27 B.
50.	,, ...	1	10	......	......	......	......	10	10 B.
51.	,, ...	1	6	......	......	......	......	6	6 B.
52.	,, ...	2	43	1	......	......	......	44	23 B, 1 R, 20 B (1st).
53.	,, ...	1	20	......	......	......	......	20	20 R.
54.	,, ...	3	131	1	1	......	......	133	86 B, 1 R, 8 B (1st), 1 R, 37 B (1st).
55.	,, ...	2	34	1	......	......	......	35	34 B, 1 B.
56.	,, ...	2	25	1	......	......	......	26	13 B, 1 R, 12 B (1st).
57.	,, ...	4	90	2	1	1	......	94	86 B, 1 R, 4 B (1st), 1 W, 2 B.
58.	,, ...	2	45	25	......	......	......	70	7 W, 5 W, 4, 2, 2, 1, 14, 6, 1, 7, 2, 4, 2, 12 (two species of Clover visited alternately).
61.	,, ...	2	10	5	......	......	......	15	5 R, 10 R.
63.	,, ...	2	28	1	......	......	......	29	28 B, 1 R.
64.	,, ...	1	21	......	......	......	......	21	21 B.
65.	,, ...	1	5	......	......	......	......	5	5 R.
66.	,, ...	2	24	5	......	......	......	29	13 R, 5 B, 11 R (1st).
68.	,, ...	2	43	1	......	......	......	44	43 R, 1 B.
69.	,, ...	1	20	......	......	......	......	20	20 R.
70.	,, ...	2	34	1	......	......	......	35	34 R, 1 W.
74.	,, ...	1	12	......	......	......	......	12	12 W.
55.		94	1605	131	16	6	1	1751	

TABLE III.—Humble-Bee, *Bombus* (many species).

Number of observation.	Name of species.	Number of species visited.	Number of visits to 1st species.	2nd species.	3rd species.	4th species.	5th species.	Total number of flowers visited.	Showing order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.
1.	*Bombus scrimshiranus*	1	?	......	......	......	......	?	? Y.
2.	*Bombus*, ? sp.	1	?	......	......	......	......	?	? Purple.
3.	"	3	110	13	2	......	......	125	30 R, 2 R, 7, 3, 10, 3, 12, 1, 27, 2, 2, 1, 2, 14 (all red, 1st and 2nd alternately), 2 R (fresh sp.).
4.	"	4	55	51	5	3	......	114	16 R, 6 R, 4 R (1st), 10 R (2nd), 1 R (1st), 5 Y, 4 R (2nd), 2 W, 19 R (2nd), 1 W (4th), 16 R (2nd).
5.	"	1	49	......	......	......	......	49	49 W.
6.	"	1	31	......	......	......	......	31	31 W.
7.	"	2	6	1	......	......	......	7	5 Y, 1 R, 1 Y (1st).
8.	"	2	5	1	......	......	......	6	5 R, 1 Y.
9.	"	1	6	......	......	......	......	6	6 R.
10.	"	5	about 200	5	3	1	1	about 210	22 Y, 1 Y, 34 Y (1st), 16 Y (1st), 1 Y (2nd), 10 Y (1st), ? Y (1st), 1 Y (2nd), 9 Y (1st), 1 R, ? Y (1st), ? Y (1st), 5 R.
11.	"	4	?	?	2	1	......	?	1 B, ? R, 1 Pink, 1 W (2nd), ? B (1st), 2 ?
12.	"	3	?	2	2	......	......	?	2 R, 2 R, ? Bluish.
13.	"	3	?	?	?	......	......	?	? B, ? R, ? B (1st), 1 R.
14.	"	1	58	......	......	......	......	58	58 B.
15.	"	1	15	......	......	......	......	15	15 B.
16.	"	1	15	......	......	......	......	15	15 B.
17.	"	1	41	......	......	......	......	41	41 B.
18.	"	1	13	......	......	......	......	13	13 B.
19.	"	1	32	......	......	......	......	32	32 B.
20.	"	1	57	......	......	......	......	57	57 B.
23.	*Anthrophora acervorum*, Fabr. ...	1	5	......	......	......	......	5	5 Y.
25.	" "	1	108	......	......	......	......	108	108 Y.
27.	*Bombus scrimshiranus*	2	?	?	......	......	......	?	? Y, ? B (both many times alternately).

Number of observation.	Name of species.	Number of species visited.	1st species.	2nd species.	3rd species.	4th species.	5th species.	Total number of flowers visited.	Order, colour and number of visits.
28.	*Anthrophora acervorum*, Fabr. ...	2	?	?	......	......	......	?	? Y, ? B (both many times alternately).
34.	*Bombus*, ? sp.	2	52	1	......	......	......	53	52 B, 1 B.
35.	"	1	7	......	......	......	......	7	7 R.
36.	"	1	9	......	......	......	......	9	9 R.
37.	"	1	11	......	......	......	......	11	11 R.
39.	"	1	4	......	......	......	......	4	4 Y.
40.	"	2	?	?	......	......	......	?	? W, ? R.
41.	"	2	3	1	......	......	......	4	2 R, 1 Y, 1 R (1st).
42.	"	2	12	11		......	......	23	12 R, 11 W (two species of *Trifolium*).
43.	"	1	15	......	......	......	......	15	8 Purple, 2 W, 5 Purple (all [illegible]).
44.	"	1	8	......	......	......	......	8	8 B.
45.	"	1	over 50	......		......		over 50	Over 50 W.
48.	"	2	?	1				?	? R, ? W [illegible]
49.	"	1	27	......				27	27 B.
50.	"	1	10					10	10 B.
51.	"	1	6					6	6 B.
52.	"	2	43	1		......		44	23 B, 1 R, 20 B (1st).
53.	"	1	20					20	20 R.
54.	"	3	131	1	1		......	133	86 B, 1 R, 8 B (1st), 1 R, 37 B (1st).
55.	"	2	34	1			......	35	34 B, 1 B.
56.	"	2	25	1			......	26	13 B, 1 R, 12 B (1st).
57.	"	4	90	2	1	1	......	94	86 B, 1 R, 4 B (1st), 1 W, 2 B.
58.	"	2	45	25	......			70	7 W, 5 W, 4, 2, 2, 1, [illegible], 2, 4, 2, 12 (two species of [illegible] visited alternately).
61.	"	2	10	5				15	5 R, 10 R.
63.	"	2	28	1			......	29	28 B, 1 R.
64.	"	1	21	......			......	21	21 B.
65.	"	1	5	......			......	5	5 R.
66.	"	2	24	5		......	......	29	13 R, 5 B, 11 R (1st).
68.	"	2	43	1		......	......	44	43 R, 1 B.
69.	"	1	20			......	......	20	20 R.
70.	"	2	34	1		......	......	35	34 R, 1 W.
74.	"	1	12	......		......	......	12	12 W.
55.		94	[illegible]	[illegible]	16	6	1	1751	

It will be observed that most of my observations have been made upon Bees, which seem to me to perform the fertilization of at least one half of all the flowers which are fertilized by insects in this country. As to Butterflies I have seldom seen one whose flight gave me the idea that the insect had the least notion as to where it was going. Generally their movements seem purposeless. Nevertheless some species, including the Fritillaries, are fairly methodic. Among the high Alps of the Canton Grisons, however, where some of my observations have been made, there are very few Bees when compared with what we have in England, whilst the number of Butterflies and Moths is so great that it hardly bears comparison with the number here. I presume, therefore, that a large number of plants growing on the Alps are fertilized by Lepidoptera, although I have only a very few observations to that effect, as insects of this class are most difficult and unsatisfactory to watch.

We have now seen that insects do possess a decided preference for a number of successive visits to the same species of flower, although this is not invariably the case. It is quite needless here to treat of the great importance of this fact to the plants themselves, or of the numerous variations and modifications of colour, form, scent, and other particulars which the plants appear to have effected in their flowers with a view of inducing the insects to be thus methodic in their habits. I cannot doubt that Mr. Darwin is right when, in speaking of the probable reasons why insects are methodic, he says ('Cross- and Self-fertilization of Flowers,' p. 419):—"The cause probably lies in the insects being thus enabled to work quicker; they have just learnt how to stand in the best position on the flower, and how far and in what direction to insert their proboscides. They act on the same principle as does an artificer who has to make half a dozen engines, and who saves time by making consecutively each wheel and part for all of them."

Although so little is really known as to the sight of insects, Sir John Lubbock's observations have satisfactorily established the fact that Bees can distinguish some at least of the colours, and that they show a preference for *blue*. Colour, however, is not the only sense which guides insects from one flower to another of the same species, although I believe it largely does so. Some other sense must have been called into use in observation No. 43, where a small Humble-Bee visited 15 flowers of *Digitalis purpurea*, some being white and others coloured; in observation No. 75, where a specimen of *Pieris brassicæ* visited flowers of *Geranium* which were both scarlet and pink; and in observation No. 48, where a small Humble-Bee visited many times both red and white flowers of the same species of *Trifolium.* It is just possible that in these cases a sense of smell may have assisted.

During my observations on Bees I have come to the conclusion that they have a *good* sight for short distances, but a *poor* sight for long distances. Often when visiting small flowers growing many on a plant, I have seen a Bee reach out and, pulling down the next nearest flower, insert its proboscis. Their general movements whilst actually visiting flowers lead me to the belief that they see precisely what they are doing whilst so engaged. But if a Bee be watched whilst not in the act of visiting a flower, its movements will be seen, I think, to be different. A Bee seldom flies straightly and directly from one flower to another unless the second be very near the first, or so conspicuous that the Bee can hardly help seeing it. On the contrary, a Bee generally goes prowling about over the leaves, grass, or herbage with an irregular zigzag line of flight until it comes within sight of a flower belonging to the species of which it is in search. Then, too, a Bee which is being watched will generally allow any one to approach it closely, provided this be done steadily and quietly; but if approached roughly or quickly the Bee flies off at once.

In opposition, however, to what has been already advanced as to the methodic habits of Bees, I have several facts to bring forward. Bees very often do not seem to be at all systematic as to the number of times they visit the same flower, but often visit a flower more than once, as stated in observations Nos. 3, 21, and 43, but especially in No. 10. In No. 20 I even caused several heads of *Scabiosa succisa* to be twice visited by picking and again presenting them to the Bee. My earlier observations, which were made in the autumn of 1881, seem to show that Bees are less methodic at that time of year than in spring and summer, when many of my later observations were made, probably because there are fewer flowers then out. It is said that Bees are unable to distinguish between some closely allied species of flowers, such as *Ranunculus bulbosus*, *R. acris*, and *R. repens*, and *Trifolium fragiferum* and *T. repens* ('Cross- and Self-fertilization of Flowers,' p. 416); and it is very possible that hybrids are thus formed, as in the genera *Verbascum* and *Primula* ('Forms of Flowers,' pp. 55 and 75). It is further noticeable in several of my observations (Nos.

34, 48, 55, 63, 68, and 70) that just before I lost sight of my Bee altogether, it appeared to become wild, and paid a visit to some flower of a fresh and altogether different species (irrespective of colour), afterwards flying right away, although it had been perfectly methodic previously. I wish to refer also to observations Nos. 3, 4, 27, and 28. In all these cases Humble-Bees paid many visits to two different species of flower at the same time, passing alternately, without respect to colour, from one to the other after several visits. It is obvious that what has been just said does not apply to these individuals; and I can only account for their movements on this supposition, that if Bees often visit one species of flower many times consecutively, because they can thus remember from one flower to the next the best way to alight and to reach the nectar of that particular species, so saving time, then these Bees were a little more highly intellectual than their fellows, and could manage to work the two species together, although I should fancy more than two would puzzle them. Nevertheless there can be no doubt that insects, more often than not, do their work in the manner which I have spoken of as "methodic" or "constant," although the extent to which these habits are developed varies greatly in the different classes of insects, and even in the different species.

With Table III. before me, and bearing in mind the fact that Bees show a preference for the colour blue, I have endeavoured to ascertain whether my figures show that Bees are more methodic when visiting blue flowers than when visiting flowers of other colours. Unfortunately all my observations on the Honey-Bee have been made when the insects were visiting yellow flowers, so that nothing can be learnt from them; but of all the 55 Humble-Bees watched, no less than 26 visited more or less blue flowers, of which 12 were perfectly methodic, 9 more nearly so, and 5 not at all. Thirteen insects visited white flowers, of which 5 were perfectly methodic and 8 not at all; 11 visited yellow flowers, and 4 were perfectly methodic, 1 nearly so, and 6 not at all; 28 visited red flowers, and 7 were perfectly methodic, 9 were nearly so, while 12 were not at all; so that by this scale of comparison, Humble-Bees are shown to be more methodic when visiting blue flowers than when visiting others; but this may be a mere coincidence. Further observation alone can decide the question.

On the Moths of the Family Urapterygidæ in the Collection of the British Museum. By Arthur G. Butler, F.L.S., F.Z.S.

[Read March 15, 1883.]

(Plate IX.)

The family of Geometrites founded by Guénée under this name can only arbitrarily be separated from the Ennomidæ. Dr. Packard says:—"The fact that genera so closely allied as *Drepanodes* and *Eutrapela* are placed separately in the families 'Ennomidæ' and 'Urapterygidæ' by M. Guénée, seems to me a proof that the groups are artificial ones and should be united."

No true Urapterygidæ have hitherto been found in the United States, and very few even in the New World; those few also appear to be so closely allied to some genera of Ennomidæ that only an arbitrary division of the two families can be maintained. On the other hand, if we follow Dr. Packard in uniting the two families, there is no knowing where to stop; inasmuch as the structure of the Urapterygidæ is repeated with slight modifications throughout the tribe. Thus, in the Palyadæ, *Byssodes appropriata* chiefly differs from the typical *Chærodes* of Guénée in the imperfect closing of its wing-cells, though its style of ornamentation widely differs. The angular-winged subcaudate Microniidæ, on the contrary, although extremely like *Urapteryx* both in form and coloration, are absolutely dissimilar in the arrangement of their wing-veins, so that they ought not to be associated.

In the generic division of the Geometrites, although neuration must be considered of the highest importance, it is nevertheless impossible to ignore the characters offered by the different forms of the wings, each accurately repeated in series of allied species.

In Guénée's description of *Urapteryx* (translated by Walker) no attention is paid to neuration; but Guénée, although he evidently regarded structure as correlated with pattern and coloration, did nevertheless give *one plate*, chiefly of neuration, as illustrative of the tribe. Walker, however, ought to have made some attempt to describe the wing-structure, as he not unfrequently did in the case of new genera.

I regard the method of description adopted on the Continent as extremely undesirable, viz. where to save the trouble of learning the names of the veins, numbers are given to them. It is popular because easy to learn; but is subject under unfavourable conditions to total failure; for, although most Lepidopterists have now adopted my method of using benzine in the examination of wing-veins *, cases may occur where by overlooking the forking of a vein the identity of every other vein in the wing is altered.

The number-system is essentially a retrograde movement. I need only refer to Von Heinemann's 'Schmetterlinge Deutschlands,' p. 6, where the veins are positively numbered from the back forwards, from the inner to the front margin. If the authors of the system in question are consistent they are utterly opposed to me in every thing; what I call the front legs are their hind legs, and the club of the antenna, where it exists, must be the last thing to describe. When I first began to describe genera, and found that Doubleday had numbered the three branches of the median vein backwards, I thought the error sufficiently grave, and I carefully avoided repeating it †; but by what argument the costal margin of a wing can be regarded as posterior and the inner margin anterior (excepting with certain Moths in repose upon a perpendicular surface) I must confess myself utterly unable to understand. In speaking of a branched vein like the median, it is in accordance with common sense to call the first branch emitted the first and not the third; therefore in this vein the branches have to be counted upwards; but this is no excuse for counting the last emitted branch of the subcostal vein as first. I hold, then, that the number-system, although easy to learn, is unreasonable and (excepting when employed by very careful observers) worse than useless.

Synoptical Diagnoses of the Genera of Urapterygidæ.

A. Primaries triangular, the outer margin not angulated.
  1. Secondaries caudate, or angulated at the extremity of the third median branch; subcostal vein of primaries 4-branched; first branch emitted before the end of the cell and united to the costal vein beyond the end.
    a. Subcostal branches of secondaries emitted almost from the same point; second and third median branches from the same point .... URAPTERYX.
    b. Subcostal branches emitted from a footstalk; second and third median branches from nearly the same point. TRISTROPHIS.

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* See Trans. Ent. Soc. 1870, p. 486.

† I since find that my example has been followed by other Lepidopterists.

2. First subcostal branch of primaries united to the costal vein by a recurrent spur beyond the end of the cell; the first and second and the third and fourth branches terminating as separate forks from well-defined footstalks.
   a. Subcostal branches of secondaries emitted near together; second and third median branches moderately wide apart.
   XEROPTERYX.
3. Subcostal of primaries 5-branched; first branch emitted before the end of the cell, united to the costal by means of a recurrent spur beyond the cell; other veins emitted regularly.
   a. Subcostal branches of secondaries emitted near together; second and third median branches from one point.
      aa. Caudal angle of males obtuse; antennæ of males simple.
      ÆSCHROPTERYX.
      ab. Caudal angle of males acute; antennæ of males strongly pectinated .... GONORTHUS.
   b. Subcostal branches of secondaries well separated at their origins.
      ba. Caudal angle of males acute; antennæ of males finely ciliated (not pectinated) .... NEPHELOLEUCA.
   c. Secondaries angulated at extremity of first subcostal as well as at third median branch; subcostal branches emitted near together; all the median branches well separated at their origins.
      ca. Antennæ of males ciliated .... THINOPTERYX.
4. First subcostal branch of primaries emitted before the end of the cell, uniting with the costal by means of an abrupt angle; upper radial emitted from the subcostal just beyond the cell; secondaries with only the usual acute angle; the subcostal branches emitted from a footstalk; median branches all well separated at their origins.
   a. Antennæ flattened, simple .... SIRINOPTERYX.

B. Primaries angulated at extremity of third median branch.
1. Primaries obtusely angulated; subcostal 5-branched; first branch emitted before end of cell, united by a recurrent spur to the costal and to the second branch at some distance beyond the cell; upper radial emitted from the subcostal close beyond the cell.
   a. Subcostals of secondaries emitted from one point at the anterior angle, and second and third medians from the posterior angle of the cell; antennæ of males serrated and penicillated.
   RIPULA.
2. Primaries acutely angulated, the margin slightly concave in front of the angle; upper radial widely separated from the subcostal.
   a. Subcostals and medians of secondaries all well separated at their origins; antennæ of males finely pectinated.
   GONOGALA.

Obs. It is possible that the last genus in this Table may be more nearly related to *Tetracis* than to *Urapteryx*, although agreeing with the latter in coloration and marking.

URAPTERYX, Leach. (Plate IX. figs. 1, 2.)

This genus requires breaking up, the neuration of the typical group being as follows:—Primaries with the costal vein rather short, terminating at a little beyond the middle of the margin; discoidal cell extending to the middle of the wing or shorter, the subcostal four-branched, the first branch emitted before but close to the end of the cell, united to the costal and separated after a considerable interval; the three others forking from a long footstalk beyond the cell; upper radial emitted from the anterior angle of the cell, lower radial dividing the discocellulars unequally, the lower being decidedly longer than the upper; both discocellulars are transverse and concave; second and third median branches emitted together from the end of the cell and far distant from the first branch; submedian vein extending to external angle: secondaries with the costal and subcostal veins closely approximated for some distance from their origin and then somewhat abruptly separating; the subcostal two-branched, the first branch emitted just before the end of the cell, the second from the anterior angle, where it represents the radial of some Moths; discocellular oblique and concave; other veins as in the primaries. In this genus the primaries are triangular, the secondaries irregularly angulated, and with a longer or shorter tail at the extremity of the third median branch*.

The following species are in the British-Museum collection:—

1. URAPTERYX SAMBUCARIA.—Phalæna-Geometra sambucaria, *Linn. Syst. Nat.* i. 2. p. 860 (1766).—Therinia sambucaria, *Hübner, Verz. bek. Schmett.* p. 290 (1816).—Urapteryx sambucaria, *Leach, Zool. Misc.* p. 80, pl. 35. fig. 2 (1814–17).—Acæna sambucaria, *Treitschke, Schmett.* vi. i. p. 85 (1827).—Germany and France; England. B.M.

2. URAPTERYX SCITICAUDARIA, *Walker, Cat. Lep. Het.* xxv. p. 1480 (1862).—India, Darjiling. Type B.M.

3. URAPTERYX PICTICAUDATA, *Walker, Cat. Lep. Het.* xx. p. 12 (1860).—N. India, Nepal. B.M.

Originally described from Sarawak. It is closely allied to the

* Some authorities, I believe, are inclined to the opinion of there being a close relationship between *Urapteryx* and *Asthenia*. I believe this view to be wholly erroneous, but in this place will not attempt to discuss the question.

preceding, but longer-winged, clearer, and less striated, with more strongly defined and usually more divergent bands.

4. URAPTERYX MULTISTRIGARIA, *Walker, Cat. Lep. Het., Suppl.* v. p. 1535 (1866).—N. India. Type B.M.

5. URAPTERYX EBULEATA, *Guénée, Phal.* i. p. 32 (1857).—U. sambucata, var., *Kollar, Hügel's Kaschmir*, p. 483 (1848).—U. kantalaria, *Felder, Reise der Nov., Lep.* iv. pl. cxxii. fig. 3 (1875).—Darjiling. B.M.

6. URAPTERYX NIVEA, sp. n.—♀. Intermediate between *U. ebuleata* and *U. maculicaudaria*; larger than the largest females of the latter species, which it most resembles, and with the form and well-marked acuminate tail of *U. ebuleata*; as in the latter species, the disk of the wings, and especially of the secondaries, is crossed by a band of grey scales much better-defined than in *U. maculicaudaria*, and the spots on each side of the tail of secondaries are reduced to mere black points; the bands are narrower and not so dark as in the last-mentioned species, the inner one somewhat concave, darker and wider apart than in *U. ebuleata*. Expanse of wings 66 millim.—Tokei, Japan. Type B.M.

The form of the wings, small spots above the tail, and somewhat different banding at once distinguish this species from the following; and its much superior size, whiter colouring, darker and more widely placed bands separate it from *U. ebuleata*.

7. URAPTERYX MACULICAUDARIA.—Acæna maculicaudaria, *Motschulsky, Bull. Mosc.* 1866, p. 196.—♀ Urapteryx luteiceps, *Felder, Reise der Nov., Lep.* iv. pl. cxxii. fig. 2 (1875).—Yokohama, Tokei, Hakodaté, Chekiang. B.M.

8. URAPTERYX CLARA, *Butler, Ann. & Mag. Nat. Hist.* ser. 5, vol. vi. p. 120 (1880).—N.E. Himalayas. Type B.M.

9. URAPTERYX PODALIRIATA, *Guénée, Phal.* i. p. 32. n. 8 (1857).—Silhet, Moulmein, Java. B.M.

TRISTROPHIS, gen. nov. (Plate IX. figs. 3, 4.)

Form of *Urapteryx maculicaudaria*, but at once distinguishable from typical *Urapteryx* by the neuration of the secondaries, the subcostal branches being emitted from a short footstalk, and the second and third median branches separated at their origins, instead of being emitted from the same point. Type *T. veneris.*

1. Tristrophis veneris.—Urapteryx veneris, *Butler*, *Ann. & Mag. Nat. Hist.* ser. 5, vol. i. p. 392 (1878); *Ill. Typ. Lep. Het.* iii. p. 29, pl. xlviii. fig. 1 (1879).—Yokohama, Tokei. Type B.M.

There are one or two species somewhat resembling this described from South America—*U. saturniaria*, Herr.-Sch., *U. platinata*, Guén., and *U. quadrifilata*, Felder; but I have had no opportunity of examining them, and the markings on their secondaries incline me to refer them provisionally to *Byssodes.*

Gonorthus, gen. nov. (Plate IX. figs. 9, 10.)

Differs from *Urapteryx* in the form of the wings—the primaries having an acute apex and straight outer margin; the secondaries with rectangular outer margin, the angle being acutely produced, but not preceded by a short angle as in the two foregoing genera; discocellular of secondaries almost straight and transverse. Type *G. flavifimbria.* The typical species is wonderfully like *Micronia* excepting in neuration.

1. Gonorthus flavifimbria.—Urapteryx flavifimbria, *Walker*, *Cat. Lep. Het.* xx. p. 8 (1860).—Jamaica, St. Domingo. Type B.M.

Urapteryx tesserata and *U. breviaria* of Guénée and Hübner should probably be placed here, so far as I can judge from Hübner's figure.

Ripula, Guénée. (Plate IX. figs. 17, 18.)

Differs from *Gonorthus*, to which it is nearly allied, in its less strongly pectinated antennæ in the male, the subangulated outer margin of the primaries, and narrower discoidal cell with inangled discocellular veinlet to the secondaries. Type *R. mahometaria.*

1. Ripula mahometaria.—Geometra mahometaria, *Herrich-Schäffer*, *Aussereurop. Schmett.* figs. 69, 70 (1850–58).—Ripula mexicaria, *Guénée*, *Phal.* i. p. 35 (1857).—Bolivia and Mexico. B.M.

M. Guénée described his *G. mexicaria* from a single female example, which is represented exactly by one of our Mexican specimens; it is hardly sufficiently distinct to be worthy of mention as a variety, since it only differs in variable characters.

2. RIPULA AREA.—Phalæna-Geometra area, *Cramer, Pap. Exot.* i. p. 88, pl. 56, D (1779).—Phalæna-Geometra areata, *Fabr. Sp. Ins.* ii. p. 256.—Calospilos arearia, *Hübner, Verz. bek. Schmett.* p. 305 (1816).—Urapteryx areata, *Guénée, Phal.* i. p. 34 (1857).—Rio Jurua, Amazons. B.M.

SIRINOPTERYX, gen. nov. (Plate IX. figs. 15, 16.)

Allied to *Gonorthus* and *Tristrophis*, with the form of wings nearly as in the former, but the neuration of the latter; the antennæ of the male thickened but not pectinated. Type *S. rufivinctata*.

1. SIRINOPTERYX RUFIVINCTATA.—Urapteryx rufivinctata, *Walker, Cat. Lep. Het.* xxvi. p. 1747 (1862).—Darjiling and Shillong. B.M.

GONOGALA, Butler. (Plate IX. figs. 19, 20.)

Primaries angulated at extremity of third median branch; discocellulars angulated; the lower radial emitted from the centre of the discocellulars; second and third median branches separated at their origins: secondaries with an acute angle at extremity of third median branch; first subcostal branch emitted before the end of the cell; discocellular veinlet concave; second and third median branches emitted separately as in the primaries: antennæ pectinated, with the pectinations well separated. Type *G. lactea*.

1. GONOGALA LACTEA, *Butler, Trans. Ent. Soc. London*, 1882, p. 341.—Chili. Type B.M.

NEPHELOLEUCA, gen. nov. (Plate IX. figs. 11, 12.)

Form of *Gonorthus*, and with very similar neuration, excepting that the subcostal branches of the secondaries are not emitted quite at the same point, that the second and third median branches are also separated by a short space at their origins, and that the radial is very oblique and subangulated towards the anterior angle of the cell: antennæ very different, not pectinated in the male, but with fine short cilia along the anterior margin. Type *N. politia*.

1. Nepheloleuca politia.—Phalæna politia, *Cramer*, *Pap. Exot.* ii. p. 65, pl. 140, E (1779).—Phalæna-Geometra politata, *Fabricius*, *Sp. Ins.* ii. p. 253.—Eulepidotis politaria, *Hübner*, *Verz. bek. Schmett.* p. 291 (1816).—Urapteryx politia, *Leach*, *Zool. Misc.* i. p. 80, pl. 35. f. 1 (1814–17).—Urapteryx complicata, *Guénée*, *Phal.* i. p. 30, pl. 6. fig. 9 (1857).—St. Domingo, Jamaica; Sarayacu and Oaxaca, Mexico. B.M.

Guénée's *Urapteryx complicata* is represented by full-sized examples of the species; the smaller specimens are frequently less fully marked with reddish. The *U. illiturata* of Guénée is apparently distinct; the costal spot of primaries is said to be bilobed. It is possible, however, that this may be only an exaggeration of a character frequently found in *Nepheloleuca politia*, this spot being in many specimens deeply indented externally.

Thinopteryx, gen. nov. (Plate IX. figs. 13, 14.)

Primaries triangular, with acute prominent apex; second subcostal with its three branches emitted before the end of the cell; lower radial emitted from the centre of the discocellulars; discocellulars forming a concave transverse line; second and third median branches well separated at their origins: secondaries with two distinct angles—the first at the extremity of the first subcostal branch, the second, which forms a short tail, at the extremity of the third median branch as usual; subcostal and second and third medians separate at their origins; the discocellular oblique and slightly concave: antennæ ciliated, not pectinated. Type *T. crocopterata.*

1. Thinopteryx crocopterata.—Urapteryx crocopterata, *Kollar in Hügel's Kaschmir*, p. 483 (1848).—Silhet, Nepal, Andamans, Java. B.M.

2. Thinopteryx prætoraria.—♀ Urapteryx prætoraria, *Felder*, *Reise der Nov.*, *Lep.* iv. pl. cxxii. fig. 13 (1875).—Silhet. ♂, B.M.

3. Thinopteryx striolata, sp. n.—Near to *T. crocopterata*, but differing constantly in the considerably darker costal border of primaries, the more distinctly striated upper surface, which gives it a mottled appearance, the more widely separated and more parallel bands across the primaries, the outer band distinctly wider, and the more densely grey-mottled character of

the secondaries, especially beyond the middle. Expanse of wings 68–73 millim.—Yokohama, Tokei, Nikko. Type B.M. This species represents *T. crocopterata* in Japan.

4. Thinopteryx nebulosa, sp. n.—Near to *T. delectans* but larger; the markings, and especially the external borders, mottled with orange; the yellow spots on the primaries forming a less distinct band and less central; there are also two blackish lines across these wings as in *T. crocopterata*, but less strongly defined, and the discocellulars are dark; the disk of the secondaries is always crossed by a more or less defined curved series of orange spots, and the border is interrupted by a blackish patch extending into the tail. Expanse of wings 69–71 millim.—E. India, Silhet. Type B.M.

This species evidently represents *T. delectans* in India. It was regarded by Kollar as a variety of *T. crocopterata*. It seems to me, however, to come decidedly closer to *T. prætoraria*. Of course it is possible, although hardly probable, that the three are forms of a trimorphic species. They are all represented in both sexes.

5. Thinopteryx delectans.—Urapteryx delectans, *Butler, Ill. Typ. Lep. Het.* ii. p. 45, pl. xxxv. fig. 2 (1878).—Yokohama, Tokei, North China. Type B.M.

Xeropteryx, gen. nov. (Plate IX. figs. 5, 6.)

This genus is so distinct from *Urapteryx* in neuration, that I feel some hesitation in placing it here, the subcostal having five branches, all being given off from a long footstalk emitted before the end of the cell—the first and second upon a separate stem emitted from the main footstalk at less than a third the distance between the cell and the apex; the third and fourth forming a short apical costal fork; the fifth emitted from below the main stem soon after the emission of the two first branches: lower radial emitted from the centre of the discocellulars, which form an uneven concave line; second and third median branches emitted separately: neuration of secondaries as in the preceding genus; form of wings also very similar, but without the second angulation of the secondaries: antennæ of male ciliated.

1. Xeropteryx columbicola.—Urapteryx columbicola, *Walker, Cat. Lep. Het.* xx. p. 11 (1860).—India, Darjiling. Type B.M.

2. Xeropteryx simplicior, sp. n.—Brownish grey, transversely striated with darker grey; costal borders, fringes, and the outer margin of secondaries white; the latter wings with a diffused longitudinal reddish nebula above the tail; a black spot on each side of the tail: wings below white, with black markings as in *X. columbicola*. Expanse of wings 58 millim.—Sarawak, Borneo. Type B.M.

Chiefly differs from *X. columbicola* in the absence of the large sulphur-yellow spot and crescent upon the primaries.

Æschropteryx, gen. nov. (Plate IX. figs. 7, 8.)

Form of *Gonorthus*; neuration nearly as in *Urapteryx*, but the antennæ of the male simple. Type *Æ. tetragonata*.—*Chærodes*, Guénée (preoccupied in Coleoptera).

1. Æschropteryx tetragonata.—Chærodes tetragonata, *Guénée, Phal.* i. p. 36, pl. 8. fig. 1 (1857).—C. bifiliaria, *Felder, Reise der Nov., Lep.* iv. pl. cxxii. fig. 1 (1875).—♂, Venezuela, Quito. B.M.

2. Æschropteryx transpectans.—Chærodes transpectans, *Walker, Cat. Lep. Het.* xx. p. 22 (1860).—♀, Venezuela. Type B.M.

The following species also belong to the genus:—*Chærodes sectata* and *C. invisata* of Guénée, *C. striata* of Stoll, and *C. invariaria* of Walker. This genus concludes the true Urapterygidæ.

EXPLANATION OF PLATE IX.

Diagrammatic representations of the neuration and ♂ antennæ of the genera of Urapterygidæ.

Fig. 1.	Neuration of	*Urapteryx.*	2.	Antenna of male.
3.	,,	*Tristrophis.*	4.	,,
5.	,,	*Xeropteryx.*	6, 6*a*.	,,
7.	,,	*Æschropteryx.*	8.	,,
9.	,,	*Gonorthus.*	10.	,,
11.	,,	*Nepheloleuca.*	12.	,,
13.	,,	*Thinopteryx.*	14.	,,
15.	,,	*Sirinopteryx.*	16.	,,
17.	,,	*Ripula.*	18.	,,
19.	,,	*Gonogala.*	20, 20*a*.	,,

On the Sense of Color among some of the Lower Animals.—Part II. By Sir John Lubbock, Bart., Pres. Linn. Soc., F.R.S., M.P., D.C.L., LL.D., &c.

[Read April 19, 1883.]

In a previous paper which I had the honour of reading before the Society on the 17th November 1881, and which is published in the Journal (xvi. p. 121), I have described some experiments on this subject.

I placed specimens of our common *Daphnia pulex* in a narrow shallow trough, threw upon them lights of various colors, and then at stated intervals counted the number of Daphnias under each color.

A large majority of the Daphnias, though not with the same species, in my experiments preferred the part of the trough on which the green light fell; but on thinking the matter over, it occurred to me that the yellow was perhaps too brilliant.

M. Merejkowski, who has since experimented on the subject, considers that the Daphnias are attracted wherever there is most light, that they are conscious only of the intensity of the light, and that they have no power of distinguishing colors. It is no doubt true that in ordinary diffused daylight the Daphnias generally congregate wherever there is most light. Their eyes are, however, so delicate that one would naturally expect, *à priori*, that there would be a limit to this; and, in fact, direct sunshine is somewhat too strong for their comfort.

For instance, I took a porcelain trough, $7\frac{1}{2}$ inches long, $2\frac{1}{2}$ broad, and 1 deep, and put in it some water containing 50 Daphnias. One half I exposed to direct sunlight and the other I shaded, counting the Daphnias from time to time, and transposing the exposed and shaded halves. The numbers were as follows:—

	In the sun.	In the shade.
At 10.40 A.M.	4	46
12.50	8	42
1.10	7	43
1.35	7	43
1.50	4	46
2.5	3	47
2.40	4	46
3	5	45
4	7	43
4.30	4	46
	53	447

This seems clearly to show that they avoid the full sunlight.

I believe, then, that in my previous experiments the yellow light was too brilliant for them; and the following experiments seem to show that, when sufficiently diffused, they prefer yellow to white light.

M. Merejkowski, however, denies to the Crustacea any sense of color whatever. His experiments were made with larvæ of *Balanus* and with a marine Copepod, *Dias longiremis*. These, if I understand him correctly, have given identical results. He considers that they perceive all the luminous rays, and can distinguish very slight differences of intensity; but that they do not distinguish between different colors. He sums up his observations as follows:—

"Il résulte de ces expériences que ce qui agit sur les Crustacés, ce n'est point la qualité de la lumière, c'est exclusivement sa quantité. Autrement dit, les Crustacés inférieurs ont la perception de toute onde *lumineuse* et de toutes les différences, même très légères, dans son intensité; mais ils ne sont point capables de distinguer la nature des ondes, de différentes couleurs. Ils distinguent très bien l'intensité des vibrations éthérées, leur amplitude, mais point leur nombre. Il y a donc, dans le mode de perception de la lumière, une grande différence entre les Crustacés inférieurs et l'Homme, et même entre eux et les Fourmis; tandis que nous voyons les différentes couleurs et leurs différentes intensités, les Crustacés inférieurs ne voient qu'une seule couleur dans ses différentes variations d'intensité. Nous percevons des couleurs comme couleurs; ils ne les perçoient que comme lumière"*.

It is by no means easy to decide such a question absolutely; but the subject is of much interest, and I have made some further experiments, which perhaps I may be permitted to lay before the Society.

Prof. Dewar most kindly arranged the apparatus for me again. He prepared a normal diffraction-spectrum, produced by a Rutherfurd grating with 17,000 lines to the inch; the spectrum of the first order was thrown on the trough. In this case the distribution of luminous intensity has been shown to be uniform on each side of the line having the mean wave-length, *i. e.* a little above the line D in the yellowish green.

I placed the centre of the trough at the brightest part of the

* 'Les Crustacés inférieurs distinguent-ils les couleurs?' Par M. C. Merejkowsky.

spectrum, a little, however, if anything, towards the green end. After scattering the Daphnias equably, I left them for five minutes, and then put a piece of blackened cardboard over the brightest part. After five minutes more, there were:—

	At the green end.	In the dark.	At the red end.
Obs. 1.	78	2	20
2.	72	3	25
3.	89	2	9
4.	82	4	14
5.	89	3	8
	410	14	76

Here the two ends of the trough were equally illuminated; but the preference for the green over the red side was very marked.

I then took five porcelain vessels, $7\frac{1}{2}$ inches long, $2\frac{1}{2}$ broad, and 1 deep, and in each I put water containing 50 Daphnias. One half of the water I left uncovered; the other half I covered respectively with an opaque porcelain plate, a solution of aurine (bright yellow), of chlorate of copper (bright green), a piece of red glass, and a piece of blue glass. Every half-hour I counted the Daphnias in each half of every vessel, and then transposed the coverings, so that the half which had been covered was left exposed, and *vice versâ*. I also changed the Daphnias from time to time.

Here, then, in each case the Daphnias had a choice between two kinds of light. It seemed to me that this would be a crucial test, because in every case the colored media act by cutting off certain rays. Thus the aurine owes its yellow color to the fact that it cuts off the violet and blue rays. The light beneath it contains no more yellow rays than elsewhere; but those rays produce the impression of yellow, because the yellow is not neutralized by the violet and blue. In each case, therefore, there was less light in the covered than in the uncovered part.

After every five experiments I added up the numbers of the Daphnias; and the following Table gives 20 such totals, each containing the result of 5 observations, making in all 100.

My reason for adding one vessel in which one half had an opaque cover was to meet the objection that possibly the light might have been too strong for the Daphnias; so that when they went under the sheltered part they did so, not for color, but for shade. I was not very sanguine as to the result of this arrangement, because I had expected that the preference of the Daphnias for light would have overcome their attachment to yellow.

The numbers were as follows:—

Number of Daphnias.

	1. In the Opaque.	1. In the Uncovered.	2. In the Yellow.	2. In the Uncovered.	3. In the Red.	3. In the Uncovered.	4. In the Green.	4. In the Uncovered.	5. In the Blue.	5. In the Uncovered.
Feb. 5	126	124	175	75	66	184	83	167	112	138
5	141	109	140	110	97	153	164	86	115	135
6	130	120	191	59	67	183	115	135	100	150
7	102	148	174	76	66	184	87	163	110	140
8	110	140	172	78	76	174	104	146	82	168
8	117	133	183	67	80	170	110	140	94	156
9	92	158	135	115	126	124	116	134	108	142
9	124	126	182	68	120	130	153	97	135	115
10	89	161	126	124	113	137	87	163	57	193
11	126	124	138	112	116	134	127	123	106	144
	1157	1343	1616	884	927	1573	1146	1354	1019	1481
Feb. 11	131	119	153	97	114	136	137	113	91	159
	112	138	164	86	100	150	106	144	78	172
13	106	144	126	124	114	136	139	111	69	181
17	114	136	159	91	118	132	137	113	130	120
18	59	191	133	117	116	134	112	138	102	148
18	54	196	146	104	109	141	126	124	106	144
18	69	181	174	76	75	175	121	129	102	148
18	50	200	146	104	66	184	120	130	95	155
19	99	151	138	112	94	156	114	136	117	133
19	97	153	141	109	95	155	148	102	137	113
	891	1609	1480	1020	1001	1499	1260	1240	1027	1473
Total	2048	2952	3096	1904	1928	3072	2406	2594	2046	2954

The result was very marked. The first two columns show the usual preference for light. If the covered half had been quite dark, no doubt the difference in numbers would have been greater; but a good deal of light found its way into the covered half. Still the result clearly shows that the Daphnias preferred the lighter half. The numbers were 2048 in the dark to 2952 in the light; and it will be seen that the preference for the light was shown, though in different degrees, in almost every series.

The result in the blue gives, I think, no evidence as to color-sense. The numbers were respectively 2046 against 2954, and were therefore practically the same as in the preceding set. Since, however, a certain quantity of light was transmitted through the blue, the result may indicate a want of sensitiveness to the blue rays.

In the red the numbers were 1928 as against 3072.

As regards the yellow, the results were very different, the numbers being, under the yellow 3096, in the uncovered part 1904. Here, therefore, we see a very distinct preference, all the more remarkable because the amount of light was really less than in the uncovered part.

In the green the numbers were much more equal, namely, 2406 against 2594. I do not, however, wish for the moment to draw any conclusion from these last figures, though I give them for what they are worth. The colored medium was, I believe, somewhat too opaque. With a more transparent green, as will be seen subsequently, the result would have been very different.

At any rate the above observations seemed to show a marked preference for yellow. Still I thought it might be objected that, though the Daphnias obviously preferred the uncovered to the shaded half of the vessel, and the yellow to the uncovered half of the vessel, perhaps in the former the uncovered water was rather too bright, and in the latter the shaded part was rather too dark, and that after all the yellow was chosen, not because it was yellow, but because it hit off the happy medium of intensity. The suggestion is very improbable, because the observations were made on several successive, and very different, days, and at very different hours. I also thought that the green was perhaps too dark; I took therefore a lighter tint, and rearranged my little apparatus as follows:—

I placed (March 26) 50 Daphnias in a trough (1), covering over one half of it with a pale green, and another 50 in a

	Trough 1.		Trough 2.		Trough 3.		Trough 4.	
	Green light.	White light.	Yellow light.	White light.	Exposed half.	Darkened half.	Illuminated half.	Unillumi-nated half.
March 27.								
12.........	35	15	33	17	35	15	28	22
12.25 ...	32	18	28	22	37	13	36	14
12.50 ...	27	23	33	17	36	14	25	25
1.40 ...	33	17	33	17	38	12	30	20
2. 5 ...	26	24	42	8	35	15	26	24
	153	97	169	81	181	69	145	105
2.25 ...	36	14	36	14	26	24	35	15
3 ...	41	9	18	32	24	26	23	27
3.25 ...	31	19	34	16	36	14	35	15
5.15 ...	35	15	25	25	31	19	28	22
5.40 ...	30	20	35	15	32	18	27	23
	173	77	148	102	149	101	148	102
March 28.								
7.30 ...	33	17	34	16	35	15	30	20
7.50 ...	32	18	37	13	27	23	32	18
8.10 ...	34	16	33	17	29	21	30	20
8.35 ...	36	14	35	15	26	24	33	17
9. 5 ...	26	24	27	23	33	17	35	15
	161	89	166	84	150	100	160	90
March 29.								
9.10 ...	36	20	25	25	29	21	32	18
9.25 ...	30	20	27	23	35	15	30	20
9.40 ...	19	31	25	25	29	21	29	21
9.55 ...	20	30	34	16	37	13	29	21
10.30 ...	30	14	34	16	20	30	26	24
	135	115	145	105	150	100	146	104
Total ...	622	378	628	372	630	370	599	401

trough (2) half of which was covered with yellow (aurine). On one side was a similar trough (3), one end of which was shaded by a porcelain plate; and on the other side a fourth trough (4), one end of which had a little, though but little, extra light thrown on it by means of a mirror. As before, I counted the Daphnias from time to time, and turned the troughs round. All four were in a light room, but not actually in direct sunshine. Thus, then, in one trough I had half the water in somewhat green light; in the third, one half was exposed and the other somewhat darkened; while the fourth, on the contrary, gave me a contrast with somewhat more vivid light. If, then, the Daphnias went under the green and yellow glass, not on account of the color, but for the sake of shade, then in trough 3 a majority of them would have gone under the porcelain plate. On the other hand, if the porcelain plate darkened the water too much, and yet the open water was rather too light for the Daphnias, then in the fourth trough they would of course avoid the illuminated half. The results show that the third trough was unnecessary; still I will give the figures, as the fourth proves that the Daphnias preferred a light somewhat brighter than the ordinary diffused light of the room.

It may be said that perhaps in the previous experiments (p. 208) the red and blue were too dark. I therefore took a very pale solution, and counted the number 20 times for the red and 10 for the blue, placing the yellow in another trough, as before, for comparison. The preference for the yellow was as marked as ever. In the experiments with the red and yellow the numbers were respectively

Trough 1.		Trough 2.	
Under the yellow.	In the uncovered half.	Under the red.	In the uncovered half.
670	330	498	502

When therefore the red solution was sufficiently light the Daphnias were indifferent to it. In the experiments with light blue the numbers were :—

Trough 1.		Trough 2.		Trough 3.	
Under the yellow.	In the uncovered half.	Under the blue.	In the uncovered half.	Under the porcelain plate.	In the uncovered half.
687	313	286	714	336	664

One other possible objection also suggested itself to me. I thought it might be said that the Daphnias went under the yellow and the green not on account of any preference for yellow or green light, but on account of the shelter afforded by the covering. To test this, I covered one half of a trough over with transparent glass, leaving the other uncovered; but after 20 observations I found the number of Daphnias in each half was practically identical. The mere fact of the covering therefore made no difference. On the whole, then, it seems to me that the Daphnias have the power of distinguishing between light of different wave-lengths, and that they prefer the light which we call yellow and green. Whether it actually appears to them as it does to us is of course another and a more difficult question—one, moreover, not yet solved even for the higher animals. Nor would I necessarily claim for them any æsthetic sense of beauty; but it must be remembered that they feed on minute algæ and other minute vegetables, the prevalent colors of which are yellow, yellowish green, and green. There is therefore nothing improbable, *à priori*, but rather the reverse, in their preference for these colors.

It will be observed that though in these vessels the Daphnias made their preference unmistakable, there were always a certain number in the least popular part. This is natural, because as the position of the light half was reversed every observation, the Daphnias had to swim across the vessel, and some naturally did not find their way to the favourite part. Then, again, in any considerable numbers of Daphnias some are changing, or have recently changed, their skin, and are therefore more or less inactive. Moreover, in pure water the desire for food must often overpower any preference for one color over another. To such causes as these we must, I think, attribute the presence of so many Daphnias in the first vessel at the opaque end, and in the second in the uncovered part.

Still, it was of course not impossible that the presence, for instance, of a certain number under the red and blue was due to a difference of taste, that though the majority preferred yellow, there might be some preferring blue or red. To test this I tried the following experiment. I placed, as before, 50 Daphnias in three of the vessels, covering one half of one with the yellow, of a second with blue, and the third with red. I then from time to time, at intervals of not less than half an hour, removed those which were in the uncovered part and replaced them with an equal number of fresh ones. If, then, some Daphnias preferred red or blue, I ought thus to eliminate the others, and gradually to get together 50 agreeing in this taste. This, however, was not the case. In the first experiment, an hour after the Daphnias were placed in the vessels there were, out of 50, 41 under the yellow, 16 under the red, and 15 under the blue, the remaining 9, 34, and 35 respectively being in the uncovered portions. These, then, I removed and replaced by others. After doing this five times, and thus adding 80 in the yellow division, 187 in the red, and 209 in the blue, the numbers were 37 under the yellow, 15 under the red, and 6 under the blue.

In the second experiment, the numbers after the first hour were 32 under the yellow, 10 under the red, and 11 under the blue. After five observations, during which 86 were added to the yellow division, 188 to the red, and 180 to the blue, the numbers were—under the yellow 35, red 11, blue 15.

In the third experiment, the numbers after half an hour were 40 under the yellow, 14 under the red, and 8 under the blue. After five observations, during which 73 were added to the yellow, 186 to the red, and 206 to the blue, there were—under the yellow 43, under the red 15, and under the blue 7.

In the fourth experiment, the numbers, after half an hour, were 38 under the yellow, 15 under the red, and 14 under the blue. After six observations, during which 89 were added to the yellow, 166 to the red, and 176 to the blue, the numbers were—under the yellow 30, under the red 19, and under the blue 10.

In the fifth experiment the numbers, after half an hour, were 40 under the yellow, 14 under the red, and 13 under the blue. After 7 observations, during which 86 were added to the yellow, 263 to the red, and 272 to the blue, the numbers were—under the yellow 38, under the red 13, and under the blue 15.

	Yellow.	Red.	Blue.
1st observation.			
At the beginning	41	16	15
„ end..........	37	15	6
2nd observation.			
At the beginning	32	10	11
„ end..........	35	11	15
3rd observation.			
At the beginning	40	14	8
„ end..........	43	15	7
4th observation.			
At the beginning	38	15	14
„ end..........	30	19	10
5th observation.			
At the beginning	40	14	13
„ end..........	38	13	15

I conclude, then, that the presence of some of the Daphnias in the red, blue, and violet is more or less due to the causes above indicated, and not to any individual preference for those colors.

My experiments, I think, show that, while the Daphnias prefer light to darkness, there is a certain maximum of brilliancy beyond which the light becomes inconveniently bright to them, and that they can distinguish between light of different wave-lengths.

I suppose it would be impossible to prove that they actually perceive colors; but to suggest that the rays of various wave-lengths produce on their eyes a different impression other than that of color, is to propose an entirely novel hypothesis.

At any rate, I think I have shown that they do distinguish between rays of different wave-lengths, and prefer those which to our eyes appear green and yellow.

The Asteroidea of H.M.S. 'Challenger' Expedition.—Part II.

By W. PERCY SLADEN, F.L.S., F.G.S.

[Read May 3, 1883.]

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Family ASTROPECTINIDÆ.

Subfamily PORCELLANASTERIDÆ.

Rays five, more or less produced. Marginal plates in superior and inferior series, thin, lamelliform, apparently naked, or covered only by an extremely thin epidermal tissue. Abactinal area covered with membrane, beset with simple spiniferous spicules or pseudo-paxillæ, which occupy the whole or only a limited portion of the area. A central epiproctal prominence, more or less defined, frequently developed into an elongate tubular prolongation. Actinal interradial areas more or less extensive, paved with thin squamiform ventral plates, more or less regularly disposed and covered with delicate membrane. Adambulacral plates elongate, simple, bearing spines (one to five in number) on the furrow-margin only; or may have one or more series of small papilliform granules on the outer part of the plate. Cribriform organs along the vertical sutures of the marginal plates in the interbrachial angles. Ambulacral sucker-feet in simple pairs, with conical pointed tips. Madreporiform body placed close to the marginal plates.

Synopsis of Genera included therein.

A. Ventral plates naked. Adambulacral plates with a single series of spines on furrow-margin only. Terminal plates large, and armed with conspicuous spines. Cribriform organs 1–9 in number.

a. Tubular epiproctal elongation. Dorsal membrane with simple spiniform spicules. Ventral plates not imbricated. Ambulacral furrows wide and exposed. Rays more or less turned back. Cribriform organs 1–3: component structure lamelliform. .... PORCELLANASTER.

b. No tubular epiproctal prolongation. Dorsal membrane with pseudo-paxillæ. Ventral plates imbricated and arranged in columns. Ambulacral furrows narrow and concealed. Rays not revertible. Cribriform organs 5–9 (3 in one case only): component structure papilliform.

α. Rays very long. Supero-marginal plates with long, robust spines, forming a single series along the median line. Ambulacral spines long and needle-shaped, radiating apart. Marginal plates united along the median line of the ray. ...... STYRACASTER.

β. Rays short. No spines on the supero-marginal plates. Ambulacral spines short, compressed, forming independent series or fans. .... HYPHALASTER.

B. Ventral plates covered with spiniform granules. Adambulacral plates with papilliform spinelets on the outer portion of the plate. Terminal plates very small and inconspicuous, unarmed. Cribriform organs 14 in number. .... THORACASTER.

Note on the "Cribriform Organs."—A peculiar structure, apparently associated with special functions, occurs in this group; and, in the form here described, is as yet unknown in other Starfishes. The structure in question is situated on the marginal plates in the interbrachial angle; and the number of the supposed organs, which is constant in a species, may vary from one to seven or even more in each angle. The following brief account will indicate the general character of the organ throughout the series. In *Porcellanaster* the marginal plates are of uniform thickness, and form a level plating, the successive plates fitting close together and are not separated by any vertical furrow or marginal bevelling of the plate. In a species possessing only one of these organs in each angle, the structure about to be described is located in the median interbrachial line, and consists of a number of greatly compressed spinelets or lamellæ arranged in vertical parallel lines. Each of the lines thus formed is equal in length to the height of the two series of marginal plates and is invested with membrane. Ten or more such lines or pseudo-lamellæ are present on either side of the median interbrachial suture; and these do not stand quite perpendicular to the plane of the marginal plates, but are directed at a slight angle towards the median suture. At the upper or aboral extremity, where the organ terminates on the dorsal area, there is a grouping of the spinelets that belong to the dorsal membrane, which are also rather more robust here than elsewhere on the surface. At the lower extremity of the organ, the outer lamellæ are rather shorter than the inner ones, and each being less than the next inward, a rounded outline is given to the lower or adoral extremity of the organ. Five or six flattened spinelets, directed upward and slightly inward, are placed round this semicircular margin and form an elegant fringe or comb, which closes over, as it were, upon the series of lamellæ.

On examining this organ microscopically it is found that the lines or lamellæ are made up of series of small lamellæ, placed end to end together, thus forming an apparently continuous line. Each component part or individual lamella stands upright upon its own rounded scale-like base; and the lamellar plates are made up of a single series of delicate rods united by irregular dissepiments, the whole structure being covered with a membrane, which appears to have been furnished with vibratile cilia. The scale-like plate which forms the basal portion is directly superposed upon the surface of the marginal plates, the parts occupied by the organ being slightly hollowed out for its reception. The outermost lines (pseudo-lamellæ) are composed of thicker individual lamellæ than any of the others, and these integral lamellæ stand wider apart and resemble flattened spinelets, each built up of several series of rods. On the upper portion of each line transition can be traced from the delicate lamellæ, above described, to the simple rounded cylindrical spinelets of the dorsal membrane.

Judging from the position and character of this organ, as well as from its relation to the dorsal area, it is not improbable that it functioned as a percolator; and in such a case it might perhaps be looked upon as the homologue of the minute ciliary spines which border the vertical furrows that run between the consecutive marginal plates in *Astropecten* and other forms.

As the structure is very constant and appears to form a reliable specific character, useful in determination, I propose for the sake of brevity to speak of it in the descriptions which follow under the name of the "*cribriform organ.*"

In species which have more than one of these organs in each interbrachial angle, the additional ones occur on the vertical sutures immediately succeeding on either side of the median line, and are identical with the median organ just described. No case of irregularity or intermission occurs in any of the specimens I have examined. The number of cribriform organs present in each angle appears to be always constant in a species; and species exist which possess 1, 3, 5, 7, 9, or even 14 of the organs respectively. The organ varies in the different species as regards its breadth, the number of vertical parallel lines or pseudo-lamellæ which compose it, and the character of the integral calcareous bodies of which these latter are formed. In *Porcellanaster* the component parts are strictly lamellar in form, as described above; whilst in the allied genera *Hyphalaster*, *Styracaster*, and *Thoracaster* the corresponding elements are papilliform.

PORCELLANASTER, *Wyville Thomson.*

Rays five, comparatively short, upturned at the extremities and frequently reverted over the dorsal area. Disk more or less inflated. Superomarginal plates not united along the median line of the ray, usually bearing a spine; and these form a series on either side of the ray. Abactinal area covered with membrane, beset wholly or in limited areas with simple spiniferous spicules. A more or less elongate tubular epiproctal prolongation * is present in the centre of the disk, which may be equal in length

* Prof. E. Perrier has recently published a note (Comptes Rendus, December 1882, p. 1379) on two small Starfishes obtained off the north coast of Spain, from a depth of 1960 and 2650 metres respectively. A new genus has been established for their reception, and named *Caulaster*, in reference to the dorsal peduncle with which they are furnished. Both specimens are very small, the larger of the two measuring only 5 millim. from the centre of the disk to the extremity of a ray; whilst in the smaller one the embryonic plating of the disk is still present. The few striking characters briefly mentioned by M. Perrier accord in every particular with *Porcellanaster*; and, as far as I am able to judge from the meagre information, I am constrained to regard these interesting Starfishes as young forms of some species of that genus. As to their identity with, or distinction from, the more western Atlantic species *P. cæruleus*, Wy. T.,

to the radius of the disk. Actinal interradial areas paved with thin plates, more or less regularly disposed, but not imbricating and not arranged in definite columns, covered with delicate membrane. Ambulacral furrows wide and exposed. Ambulacral spines one to three in number, elongate, tapering and sharply pointed, usually radiating apart. Cribriform organs one to three in number. Terminal plates large and robust, armed with prominent spines.

Synopsis of Species herein described.

A. One cribriform organ in each angle. Ambulacral spines 2–3. No segmental pits or papillæ.
- † Rays short. Dorsal membrane with spinelets confined to limited areas .... *cæruleus.*
- †† Rays long. Dorsal membrane entirely covered with spinelets.
  - * Rays tapering. Spines on each supero-marginal plate, long and delicate. Terminal plate small, with 5 spines. Spinelets of disk clavate .... *caulifer.*
  - ** Rays broad and robust. Spines on two plates only, stout. Terminal plate large and tubercular, with 3 spines. Spinelets of disk cylindrical .... *tuberosus.*

B. Three cribriform organs in each angle. One ambulacral spine. Segmental pits and papillæ.
- † Rays long and robust. Dorsal membrane entirely covered with spinelets. Spines on each supero-marginal plate, long and thick .... *crassus.*
- †† Rays short and delicate. Dorsal membrane with spinelets confined to limited areas. No spines on the supero-marginal plates or only rudimentary .... *gracilis.*

PORCELLANASTER CÆRULEUS, *Wyville Thomson.*

Porcellanaster ceruleus, *Wyville Thomson* (1877), *Voy. of 'Challenger,' Atlantic*, vol. i. p. 378, figs. 97 & 98.

Marginal contour substellate, with five moderately developed

I am not in a position to express an opinion. The smallest examples of that form with which I am acquainted are larger than those named *Caulaster pedunculatus* by M. Perrier.

In referring to the alliance of his type with *Ctenodiscus*, my friend and colleague states that the marginal plates of the young specimens under discussion form only a single row. I venture to think that on closer examination a double row (*i. e.* supero-marginal and infero-marginal series) will be found to exist, as is distinctly the case in *Ctenodiscus.*

The interesting form recently described by Danielssen and Koren under the name of *Ilyaster mirabilis* (Nyt Mag. f. Naturvidensk. 1883, bd. xxviii. 1, p. 4) is unquestionably more nearly allied to the genus *Astropecten* than any of the forms under notice.

rays proceeding from a truly pentagonal body-disk, the lesser radius being in the proportion of 48–50 per cent.; $R=22$ millim., $r=10{\cdot}5$ millim. (the largest example). When viewed from above, the rays seem comparatively small and have the appearance of springing somewhat rapidly from the angles of the disk, the interbrachial angle being very wide and not unfrequently quite straight or even curved outward, rather than rounded. Disk more or less gibbous and inflated, the height being sometimes equal to one third of the greatest diameter, but generally less. The arching or inflation of the dorsal surface extends along the ray and tapers off with a graceful curve towards the extremity, which causes the rays to have a very short appearance when seen in profile.

Dorsal area covered with a thick coriaceous integument, the usual meshwork skeleton of calcareous plates being altogether wanting. The membrane is indurated with a number of minute circular spicules, some of which bear a vertical spinelet, resembling the surface-spicules of *Thyonidium* and other Holothuroids. These spinelets are sparsely distributed over the central portion of the dorsal area and along bands that run therefrom to the arm-angle, in the median interradial line. The spinelets are long and thin, and being made up of fine calcareous rods united by short transverse dissepiments present, under the microscope, a very open structure somewhat resembling the delicate hair-like spines of certain irregular echinoids. The spinelets are clothed with thick investing membrane, which not unfrequently develops a knob at the extremity, and gives a club-shaped character to the appendage. A more or less prominent tubular epiproctal prolongation is present in the centre of the disk; in some examples measuring between two and three millim. in length, but shorter in others. It is a subcylindrical tube less than a millimetre in diameter, springing directly from the dorsal area, tapering very slightly towards the extremity, and is indurated with a close plating of very minute spinulate spicules.

Marginal plates form a deep conspicuous band, and stand as a perpendicular wall in the interbrachial angle, bending gently inward above and below. Along the rays the supero-marginal series arch well over on the dorsal surface, and leave only a very constricted space along the median line of the ray between the corresponding plates of either side. The superior series are 6 or 7 in number exclusive of the terminal, are bounded by straight lines, and vary from a quadrate to a subrhombic form according to position. The height and length are nearly equal, the latter being usually the greatest, although in some specimens the proportions may be reversed. Normally each of the supero-marginal plates bears a short conical spinelet on its upper edge; but not unfrequently these become aborted into little more than tubercles and are sometimes absent altogether, especially in those plates which are innermost in the arm-angle, and sometimes also on the penultimate plate of the ray. The terminal plate is moderately large and prominent, with the dorsal surface slightly tubercular, the adoral margin deeply indented in the median line, and the lateral angles fully rounded. The whole plate is directed at a slight angle upward in relation to the ray, a circumstance which emphasizes the strongly upturned appearance presented by the rays, the general habit of which seems always to be more or less bent upward or backward. Three moderately robust spinelets are borne on the terminal plate—one placed at the summit of the tubercular swelling in the median line of the ray and directed vertically upwards; and two somewhat smaller ones, which stand one on either side at the extreme anterior lower angles of the plate and directed outward. The infero-marginal plates usually correspond both in number and in length with the companion superior series; but sometimes a little irregularity occurs at the extremity of the ray, and an additional plate may be present. The infero-marginal plates are not so high as the superior series, and are longer than high, excepting perhaps one or two of the innermost plates of the angle. The ventral edge of the plates is curved outward, which gives a festooned appearance to the lower margin of the series; and after the first two plates in the arm-angle the succeeding ones have their proximal end higher than the distal end, so that the series tapers off gradually towards the extremity of the ray. Cribriform organs, one in each interbrachial angle, rather broad and well defined; structure lamelliform (*cf.* description above).

Ambulacral furrows wide, open, straight, tapering from the mouth to the extremity, occupying nearly the whole of the under surface of the ray. Adambulacral plates rather short and broad, with the adoral and aboral extremities somewhat incurved, leaving a small cavity between adjacent plates, which is filled in with membrane. Each plate bears two short, sharply-pointed, conical ambulacral spinelets, the adoral one being longest. The spinelets are placed slightly oblique, and are covered with an investing membrane which unites them together at the base and joins them up to the neighbouring pairs, concealing to a certain extent their actual size and shape.

Mouth-plates moderately large and prominent, sharply upturned along the line of junction, forming a swollen, semitubercular keel considerably elevated above the general surface of the ventral area. A single mouth-spine is borne at the mouth-angle, placed on the line of suture and directed inwards; and two smaller, compressed, subtriangular mouth-spines stand on the margin of each mouth-plate near their aboral extremity. No secondary mouth-spines are present on the surface of the mouth-plates.

The peristome is wide, occupying fully two fifths of the ventral area of the disk; and the mouth is situated in the centre of a naked leathery membrane and furnished with a well-developed muscular lip.

The interbrachial areas form a fairly regular equilateral triangle—the distance from the innermost point of the mouth-angle to the place where the area terminates and the marginal plates join up immediately to the adambulacral plates being about halfway out on the ray, and approximately equal to the base of the area that extends along the arm-angle. The area is covered with a compact pavement of calcareous plates, subhexagonal or subquadrate in form, arranged in columns parallel with the median interradial line. The whole is covered with a thick membrane, through which the plates are scarcely perceptible until the specimen is dried.

The madreporite is large and conspicuous, subcircular or oval in form, and situated in an interradium close up to the dorso-marginal plates, and consequently adjacent to the cribriform organ. Sometimes it is subtriangular in contour, with the base directed to the margin, and the striæ form lines sharply bent at an angle, running more or less parallel with the sides of the triangle, the open angle being directed towards the base.

Colour, in alcohol, yellowish white, with a bluish-grey shade over the disk. The marginal plates and the actinal interbrachial areas have a peculiar glazed appearance, consequent on the character of the investing membrane.

Station 45. Lat. 38° 34′ N., long. 72° 10′ W. Depth 1240 fms.; bottom temperature 2°·4 C.; mud.

Station 46. Lat. 40° 17′ N., long. 66° 48′ W. Depth 1350 fms.; bottom temperature 2°·3 C.; mud.

Station 47. Lat. 41° 15′ N., long. 65° 45′ W. Depth 1340 fms.; mud.

PORCELLANASTER CAULIFER, n. sp.

Rays five, moderately long and slender, not much broader at the base than at midarm, tapering only slightly. Interbrachial angles rather flatly rounded; the lesser radius in the proportion of 30 per cent.; $R=21$ millim., $r=6{\cdot}5$ millim. Disk high, gibbous, and much inflated. Dorsal area covered with an integument, beset with spinelets, excepting at the very base of the rays. The spinelets are simple, delicate, clavate or thickened at the extremity, covered with membrane, and rather widely spaced. Large papulæ-like bodies are interspersed here and there. Tubular epiproctal prolongation very long, nearly equal to the lesser radius, rather narrow and tapering towards the extremity.

Marginal plates moderately high, forming a perpendicular wall in the interbrachial angle, but arching over on the dorsal surface of the rays, and leave only a narrow space along the median line between the corresponding plates of either side. The supero-marginal series are seven in number, exclusive of the terminal; all are longer than high, and each carries a long, delicate, acicular spinelet. The terminal plate is large and elongate, very slightly prominent dorsally, and flattened; and normally carries three spinelets, though sometimes more are present. These are longer than the spinelets on the other supero-marginal plates and are delicate and acicular; one is placed above the termination of the ambulacral furrow, and one on either side a little beneath. Occasionally one or both of these lateral spines may be reduplified, thus producing the additional number. The infero-marginal plates correspond in number and length with the superior series, and are, like them, longer than high; they do not curve round on the actinal surface of the ray, which is flat. Cribriform organs, one in each angle, very broad, well defined, and with a deep depression down the median line; structure lamelliform.

Ambulacral furrows broad, open, and straight. Adambulacral plates small, rather elongate in the direction of the ray and rather widely separate. The margin towards the furrow is incurved, and the adoral extremity is somewhat scooped out and has the margin slightly lipped, the aboral extremity of the next plate being rounded, thickened, protruded, and lipped in correspondence; but the two do not join up closely, and a narrow vacant space is left between. Ambulacral spines two, minute, delicate, acicular and sharply tapering, the adoral one longest and placed at the extreme adoral end of the margin of the plate, and the companion spine situated at the commencement of the curve along the furrow-margin; the long spine is consequently directed almost transversely across the furrow, whilst the small spine stands at an angle of about 45° to it.

Mouth-plates rather broad and suboval, elevated into a moderately high and well-rounded keel, a small elliptical space being left between the two adjoining plates near the middle of the median line. The aboral extremity of the plates is gracefully rounded, and the margins of the plates do not meet along the lower portion, but leave a triangular outline of the odontophore visible. Mouth-spines: one short conical spinelet at the adoral peak of the mouth-angle, standing at the junction of the two plates; and two small spinelets, similar to this, on the lateral margin of each plate. The aboral spinelet is placed near the middle of the margin, and the companion one, which is smaller, nearer the adoral extremity of the plate. All the mouth-spines are smaller than the ambulacral spinelets.

Interbrachial areas small, subtriangular, covered with membrane; plating irregular and small.

Colour, in alcohol, greyish white, with a darker shade of bluish grey over the disk.

Station 191. Lat. 5° 41′ S., long. 134° 4′ E. Depth 800 fms.; bottom temperature 3°·9 C.; mud.

PORCELLANASTER TUBEROSUS, n. sp.

Rays five, interbrachial angles well rounded, the minor radial proportion being 32 per cent.; $R=18{\cdot}5$ millim., $r=6$ millim. The rays spring gradually from the angle and taper moderately towards the extremity, maintaining a robust character throughout. Disk not high, and very slightly inflated. Dorsal area covered with a rather fleshy integument beset with simple spinelets somewhat closely placed; these are short, cylindrical, obtuse, covered with membrane, and occupy the whole of the surface excepting only the extreme angle at the base of the ray. A well-developed epiproctal tubular prolongation rises from the centre of the dorsal area, and is nearly equal in length to the distance between the centre and the inner edge of the marginal plates in the arm-angle; it tapers very slightly towards its extremity and is indurated with spicular spinelets like the rest of the dorsal membrane.

The marginal plates form a deep margin and curve over roundly in the interbrachial angles, the inferior as well as the superior series being visible from above. Upon the rays the superior series arch well over and almost meet in the median dorsal line, giving to the ray a more or less subcarinate character. The supero-marginal plates are four in number from the median interbrachial line to the extremity, exclusive of the large terminal plate, and all are distinctly longer than high. The second and third supero-marginal plates from the interbrachial line bear short conical upright spinelets; but all the rest are unarmed excepting the terminal plate, which carries three spines—one at the extremity in the median line of the ray, and one on either side at the anterior extremity of the inferior margin of the plate. The terminal plate is swollen and prominently tubercular dorsally, and is excavated on its outer extremity for the passage of the terminal ambulacral tube. In one ray of the specimen under notice, the penultimate supero-marginal plates are also swollen and ankylosed, in such a manner as to resemble the terminal plate, and bear a single spinelet. The infero-marginal plates are five in number, and are much shallower than the superior series and also shorter. The two series consequently do not correspond, a result probably brought about by the extreme development of the terminal plate, which occupies the space both of superior and inferior plate. Cribriform organs one in each angle, rather broad and with a deep depression down the median line; structure lamelliform.

Ambulacral furrows wide and open, occupying nearly the whole of the actinal surface of the ray. Adambulacral plates small, and form regular triangular prominences which indent, as it were, the margins of the furrow. Ambulacral spines two on each plate, short, subconical, sharply pointed or thorn-like, placed side by side on the aboral side of the projecting angle; they are consequently directed aborally and at an angle towards the furrow, diverging also slightly from one another.

Mouth-plates rather large, forming an acute angle adorally, with an elevated angular ridge along the line of suture, each plate being strongly bent downwards and having the upturned edges compressed together to form the keel. The aboral extremity is more elevated than any other part and presents a sharp angular peak, the mouth-plates sloping down therefrom with a graceful inward curve to the level of the interbrachial area. A single short conical mouth-spine is placed at the extremity of the adoral peak; and two others, about equal in size to the ambulacral spines, stand on the lateral margins of each plate, the most adoral of the two being situated nearly midway between the extremities of the margin.

The actinal interbrachial areas are small and sagittiform in outline, and do not extend beyond the third adambulacral plate. The plates are small, subregular, transversely elongate on the outer portion of the area, and with a tendency to imbricate, this character, however, being so faintly presented that it is difficult to say whether imbrication really exists or not.

Colour, in alcohol, greyish white, rather darker over the dorsal area of the disk.

Station 237. Lat. 34° 37′ N., long. 140° 32′ E. Depth 1875 fms.; bottom temperature 1°·0 C.; red clay.

PORCELLANASTER CRASSUS, n. sp.

Rays five, elongate, robust, gradually tapering from the base to the extremity. Disk small. Interbrachial angles well rounded, the lesser radius being in the proportion of 30 per cent.; $R=35$ millim., $r=10{\cdot}5$ millim. Disk not high and only slightly inflated above the level of the marginal plates.

Dorsal area much contracted in consequence of the inward arching of the marginal plates, these latter forming a broad border enclosing a regular pentagonal area when seen from above. The whole dorsal area, excepting a very small space at the base of the rays, is beset with simple spinelets, uniformly distributed over the surface and moderately well spaced, the spinelets being very small, short, cylindrical, and invested with membrane. In the interspaces between the spinelets, small papulæ may, with difficulty, be detected here and there; in external appearance they resemble the spinelets, but are rather larger and thicker. A broad, tapering, epiproctal tubular prolongation, about 3 millim. in length, is present in the centre of the disk.

Marginal plates high, arching inward, and forming a sloping or bevelled edge to the disk in the interbrachial angles; and with a similar inclination also continued along the rays. The dorsal surface of the rays is consequently arched, and the supero-marginal plates of the two sides almost meet in the median line, being separated only by a narrow furrow. The actinal surface of the ray is flat. The supero-marginal plates are higher than long, and each bears a large robust spinelet nearly as long as the height of the plate. The innermost spinelet on each side of the arm-angle is smaller than any of the others. There are seven supero-marginal plates from the arm-angle to the tip of the ray, exclusive of the terminal plate. This latter is large and very prominent, compressed laterally, high, tubercular and rounded dorsally, and bears four spines—one placed in the median line above the termination of the ambulacral furrow, and one on either side of the furrow at a lower level, all the three being close together at the very extremity; whilst the fourth spine is placed in the median line well back on the tubercular elevation of the terminal plate. The infero-marginal plates, which are nine in number, are longer than high and do not curve round on the actinal surface, but rise abruptly at a sharp angle to it. At the extremity of the ray there are occasionally two or three small irregular supplementary plates intercalated between the dorsal and ventral series, but which in no way interfere with the form or position of the terminal plate. Cribriform organs three in each angle, well separated, the median one broadest, each with a depression down the median line; structure lamelliform.

Ambulacral furrows wide, straight and open. Adambulacral plates elongate in the direction of the ray, their form simulating the appearance in outline of caudal vertebræ. Each bears a single short curved ambulacral spinelet articulated at the adoral extremity of the margin and usually directed transversely across the furrow, or sometimes at an angle more adorally, the curvature of the spine being downwards. Midway between the extremities of the plate is placed a small, thin, semicircular scale-like papilla, with the straight base upon which it is articulated running parallel with the furrow, and having the rounded free lip directed outward. Each of these papillæ shut down upon a small cavity or pit, the function of which is as yet unknown. The cavities are filled with very fine dark-coloured matter, which may either be mud or excreted matter. I shall speak of these structures as *segmental pits* and *papillæ*.

Mouth-plates large and prominent, the mouth-angle presenting a broad well-rounded keel. At the aboral extremity there is a graceful slope; the margins of the plates are united, and do not expose the odontophore. In the median line of the keel, however, midway between the extremities, a hollow elliptical space occurs where the margins of the plates do not meet. The adoral extremity is somewhat rounded, and a single short conical spinelet is borne at the union of the two plates, occasionally with a small secondary companion standing above it. No other mouth-spines are present on the plates. On the side of each mouth-plate two of the segmental pits and their papillæ are present: the aboral one is the larger of the two, and is placed rather nearer the aboral extremity than midway on the plate, the smaller pit and papilla being about equidistant between the adoral extremity of the mouth-plate and its larger companion. Actinal interradial areas very small and subtriangular, covered with a leathery skin through which the plating is scarcely discernible.

Colour, in alcohol, yellowish grey, with a brownish shade near the disk, darkest near the borders of the area adjoining the marginal plates.

Station 286. Lat. 33° 29 'S., long. 133° 22′ W. Depth 2335 fms.; bottom temperature 0°·8 C.; red clay.

PORCELLANASTER GRACILIS, n. sp.

Rays five, rather long and slender, slightly tapering, somewhat flattened. Interbrachial angles wide, the immediate arm-angle being more or less straight. Minor radial proportion 45 per cent.; $R=10$ millim., $r=4{\cdot}5$ millim. Disk moderately high and inflated. Dorsal area covered with a thin membrane. Spinelets, borne on spicule-like plates, confined to bands along the interradial lines, and a few surrounding the epiproctal tube, the radial area being entirely without spinelets. The spinelets are very minute, little more than microscopic spicules, elongate, cylindrical, not tapering, covered with a thin membrane through which the calcareous base and shaft are distinctly visible. The tubular epiproctal prolongation is moderately well developed, broad at the base and tapers rather rapidly.

Marginal plates not high, forming an almost perpendicular wall which bends inward very slightly; they do not arch over on the sides of the rays and their curvature produces only a slight rounding of the margin. The dorsal area of the ray is flat, and the space which intervenes between the marginal plates of either side is covered with membrane. This band is nearly uniform in breadth throughout, and is equal to one third of the greatest breadth of the ray; it extends up to the extremity, the adoral margin of the terminal plate being indented for its continuation. The supero-marginal plates are eight in number, counting from the median interbrachial line and exclusive of the terminal. Their shape is nearly quadrate, the most inward and the most outward plates having the height rather greater than the length, whilst those midway present the reverse proportions. The infero-marginal series correspond in number with the superior series and, excepting the innermost plate, have the length greater than the height. Each of the supero-marginal plates normally carries a minute tubercle or rudiment of an aborted spinelet; but in some instances even this is wanting. The terminal plate is not at all gibbous or tubercular, and its size and outline is conformable in every way to the regular tapering of the ray. Three small delicate spines are borne on the terminal plate—one placed at the extremity, in the median line, which points upward and outward; and one on either side, at a lower level, which are separated by the furrow, and directed horizontally and radiate slightly outward from the axial line of the ray. Cribriform organs three in each angle, the lateral ones very narrow, all well spaced; structure lamelliform.

Ambulacral furrows wide, straight or very slightly petaloid, and open. Each adambulacral plate bears a single ambulacral spinelet, also a rather large segmental pit and papilla. The ambulacral spine, which is placed at the adoral extremity of the plate, is comparatively robust, cylindrical, slightly tapering, and longer than half the breadth of the furrow, over which it is directed horizontally and slightly inwards (adorally). The segmental papilla is subcircular in shape, nearly half as large as the whole adambulacral plate, and is situated midway between the bases of adjacent ambulacral spinelets, the margin towards the furrow being straight. Towards the end of the ray the papillæ are turned back and directed slightly over the furrow, instead of being closed down upon the surface of the plate; and the pit is probably aborted.

The mouth-plates form a rather broad mouth-angle, presenting a well-developed keel along the median line of junction, more or less imperfectly closed along the suture and widely open at the aboral extremity. A single, short, conical, sharply pointed mouth-spine to each mouth-angle stands at the innermost point and in the median line. Two large segmental papillæ occupy nearly the whole of the lateral portion of each mouth-plate; they stand close together, touching one another, and the aboral one is the larger of the two.

The actinal interbrachial areas are small; and the squamous plates are comparatively few in number, these being rather large in the immediate angle, though very narrow and elongate near the margin.

Colour, in alcohol, greyish white, excepting the dorsal membrane, which is bluish grey.

Station 298. Lat. 34° 7′ S., long. 73° 56′ W. Depth 2225 fms.; bottom temperature 1°·3 C.; grey mud.

Styracaster, n. gen.

Rays five, long and attenuate, incapable of being reverted. Superomarginal plates meet in the median dorsal line, encasing the ray, and bear long, robust, cylindro-conical spines which form a single series along the median dorsal line. Abactinal area covered with membrane, beset with simple spiniferous spicules or with pseudo-paxillæ. No specially developed epiproctal protuberance. Actinal interradial area paved with thin, smooth plates, arranged in regular columns, more or less clearly imbricating, and covered with a delicate membrane. Ambulacral furrows narrow and more or less enclosed. Ambulacral spines elongate, needle-shaped, and with a tendency to radiate apart. Cribriform organs three to seven in number in each angle.

Styracaster horridus, n. sp.

Rays five, very long and slender, compressed laterally, and tapering to the extremity. The interbrachial angle is very wide, and its rounding is more or less obliterated by the subpentagonal character of the disk. The lesser radius is in the proportion of 20 per cent.; $R=75$ millim., $r=15$ millim.; $R=5r$. The disk is not high, although capable of being inflated to a slight extent above the level of the marginal plates. Dorsal area covered with a leathery integument, beset with minute, compact, and closely crowded pseudo-paxillæ of 4–8 spinelets, occupying the whole area. The paxillæ are smaller in the immediate centre of the disk, but there is no special protuberance. The actinal portion of the disk slopes downwards, with an inward bending curve from the margin to the mouth-plates, producing a very prominent convexity on the under surface.

Marginal plates deep and almost vertical. Along the whole of the ray beyond the disk the supero-marginal series of either side meet, and, from being bent inwards very slightly, produce the laterally compressed and high-arched character of the ray. The supero-marginal series are 23 in number on one side of a ray, and all the plates are longer than high. Along the whole of the free portion of the ray each alternate supero-marginal plate bears a long sharply-pointed spine on its upper edge; and the spine-bearing plates of the two sides of a ray alternate, the unarmed plate of the one side corresponding to the armed plate of the other; hence it follows that a straight single line of vertically directed spines extends along the whole of the median dorsal line. The spines are robust at the base, conical, and taper to a very finely pointed extremity. The spines are longer than the depth (height) of the ray, and they normally decrease in size as they proceed outwards; but the regularity of this is sometimes broken by the occurrence of a shorter spine here and there. The spines are slightly curved in the plane of the direction of the ray, the point turning outwards. Occasionally a small additional spine is intercalated here and there in the otherwise equally spaced series, in consequence of the corresponding plates of the two sides of the ray each bearing a spine. The terminal plate is rather large, compressed, and elongate, its dorsal surface sloping upwards at an angle of 45° from the general dorsal line of the ray, and its ventral surface is rounded, thereby emphasizing the character of the upturned tip of the ray. The terminal plate bears three spines—one at the extremity in the prolongation of the median dorsal line, and one on either side at a lower level on the furrow-margin, all quite at the extremity and close together. In a large specimen an additional spine is present, larger than the terminal dorsal one, and placed behind it in the median dorsal line of the plate.

The infero-marginal plates are much shallower than the superior series, their length being nearly twice their height. In large specimens they frequently alternate, instead of corresponding, with the companion infero-marginal, especially on the outer part of the ray; and sometimes an intermediate lateral series of plates, almost as large as the infero-marginals, is intercalated between the dorsal and ventral series, and entirely separates them. This intermediate series may be represented by only a few plates on the outer part of the ray, or may be continuous along a considerable portion of the ray. Cribriform organs 7–9 in number in each angle, very wide, and occupy nearly the whole of the plates, in large examples adjacent organs being confluent in the neighbourhood of the horizontal suture; structure papilliform.

The ambulacral furrows are wide when expanded, occupying the whole of the actinal aspect of the ray; but when contracted are arched over and closed in by the ambulacral spines. The adambulacral plates are elongate and subrhomboid, the margin towards the furrow and the ventral surface being incurved, suggesting the appearance of a caudal vertebra. Ambulacral spines four in number, with aboral spine longest, along the greater portion of the ray; near the mouth five spines, short and subequal. The spines are comparatively short, with a wide robust base, thence taper and sharply pointed and slightly compressed, and all radiate at different angles from the plate. On the plates near the mouth the spines are much shorter, subequal, rapidly pointed, and quite flat. The bases of these spines are united by a more or less continuous membrane. In large specimens a small granule is present, behind the ambulacral spines, close to the adoral extremity of the adambulacral plate; and near the mouth even two or three are sometimes found.

Mouth-plates large and prominent, with a widely open median suture, the apposed margins of the plates being bent downward with a gentle curve until at right angles to the plane of the actinal surface. There is a comb of 7 or 8 short, flat spinelets, similar to those on the innermost adambulacral plates, on the margin of the plate which abuts onto the furrow, and one or two more prominent and conical ones at the innermost extremity, directed towards the centre of the peristome. No spinelets or tubercles are present on the surface of the mouth-plates, although in the largest specimen four or five granules form a line parallel with the sutural margin. The actinal interbrachial areas are large and elongate in the prolongation of the median interbrachial line, and are covered with squamous plates, the whole being covered with a thin membrane. The plates are broader than long, imbricate slightly, and are arranged more or less in columns, which latter, however, may become somewhat irregular as they approach the mouth-angle, consequent on the increase in the size of the plates, which are also more irregular in shape. A few small granules very widely and irregularly placed occur on the plates here and there.

Colour, in alcohol, greyish white, the paxillar area and the cribriform organs having a slightly brownish tinge.

Station 346. Lat. 2° 42′ S., long. 14° 41′ W. Depth 2350 fms.; bottom temperature 0°·4 C.; *Globigerina*-ooze.

STYRACASTER ARMATUS, n. sp.

Rays five, long and slender, subcylindrical, nearly uniform in thickness throughout their length, the expansion at the base and the attenuation at the tip being very slight. Interbrachial angle very wide, with the curve somewhat flattened in conformity with the pentagonal character of the disk. The lesser radius in the proportion of 28 per cent.; $R=38$ millim., $r=11$ millim. Disk depressed, not inflated, and not higher than the marginal plates. Dorsal area covered with a leathery integument beset with minute imperfect pseudo-paxillæ and simple spiculate spinelets closely crowded, the general appearance being that of spinelets only. Spaces at the base of the rays naked. No definite epiproctal protuberance, a faint indication of the centre only present.

Marginal plates high, curving inward slightly above and below, and forming a rounded margin. The supero-marginal series are 9 in number from the median interradial line to the extremity, exclusive of the terminal, and all are considerably longer than high. Along the rays, commencing at the fourth plate from the arm-angle, the supero-marginal plates of either side meet in the median dorsal line and entirely encase the upper portion of the ray. The ray is rather compressed laterally, and the dorsal surface is arched. Each alternate supero-marginal plate along the ray bears a large robust conical spine placed in the median line of the ray, the series forming a single line of five spinelets, which stand perpendicular to the ray and diminish in size as they proceed outward. The longest spinelet remaining measures about 6 millim., and the tip appears to have been broken. The penultimate supero-marginal plate is small, and the ray is slightly bent upwards at the extremity. The terminal plate is small and comparatively inconspicuous, not at all swollen or tubercular, and is less than the pair of antepenultimate supero-marginal plates. It bears three spinelets, one in the median line above the extremity of the ambulacral furrow, and two beneath, all close together. The infero-marginal plates correspond in number with the dorsal series, but their length is very much greater in relation to their height—fully three times. The four outermost plates do not correspond in breadth with the companion supero-marginal series. Cribriform organs three in number in each angle, rather broad, but well defined; structure papilliform.

Ambulacral furrows very narrow, quite closed-in by the over-arching adambulacral plates and spinelets. Adambulacral plates elongate and vertebra-like, the margin to the furrow being deeply scooped out, the extremities prominent and thickened. Ambulacral spines three, moderately long, sharply tapering and slightly compressed: two stand near the adoral extremity of the margin, equal in length, stretching over the furrow, and radiating apart from one another; the third spinelet is slightly smaller, placed about midway on the margin of the adambulacral plate, and is directed in the same direction as the aboral of the two spines. The spinelets are invested with a very fine membrane, which is continuous at their bases, and the spinelets of one side of the furrow interlock with those from the other. Behind the furrow series, at the adoral end of the plate and standing on the prominent swelling, away from the margin of the furrow, a small conical spinelet rises perpendicularly from the surface of the plate; and this becomes more or less rudimentary as it proceeds along the free portion of the ray.

The mouth-plates, which are large, prominent, and not united along the median suture, have a peculiar appearance, resembling the shape of a coulter in a marked degree. The mouth-spines 5 or 6 in number, placed side by side along the lateral margin of the plate, are the same in length and character as the ambulacral spines, and they interlock with the corresponding spines of the neighbouring mouth-angle. About three small, aborted, tubercular spinelets situated on the surface of the plate are probably the representatives of secondary mouth-spines. The mouth-spines are wide apart and unclosed at their aboral extremity, and expose the odontophore. Actinal interbrachial areas rather large and triangular, covered with squamous ventral plates, which are narrow, elongate, imbricating, and regularly arranged in columns on the outer half of the area, but become larger, broader, sub-rotund and irregular as they approach the mouth-angle. The plates are smooth, without granules, and the investing membrane is of such remarkable thinness that its presence is almost questionable.

Colour, in alcohol, grey, with a slightly brownish shade over the paxillar area.

Station 224. Lat. 7° 45′ N., long. 144° 20′ E. Depth 1850 fms.; bottom temperature 1°·3 C.; *Globigerina*-ooze.

HYPHALASTER, n. gen.

Rays five, short, incapable of being reverted. Disk more or less depressed and pentagonal. Supero-marginal plates devoid of spines, sometimes uniting in the median dorsal line and enclosing the ray. Abactinal membrane with pseudo-paxillæ; simple spinelets also present in some forms on the outer part of the area only. A conical epiproctal protuberance may be more or less defined in the centre of the disk, similar to that present in some species of *Astropecten*, but not developing the tubular structure of this appendage found in *Porcellanaster*. Actinal interradial areas extensive, paved with numerous thin plates arranged in regular columns and imbricating. Ambulacral furrows narrow and concealed. Ambulacral spines short, compressed, three to five in number, usually forming a kind of fan or independent series on each plate. Cribriform organs five to seven in number in each angle.

Synopsis of Species herein described.

A. Five cribriform organs in each angle. Dorsal area with prominent groups of paxillæ .... *diadematus.*

B. Seven cribriform organs in each angle. No prominent groups of paxillæ on the dorsal area.

† Supero-marginal plates meet in the median line. Cribriform organs very narrow. Secondary row of granules behind the ambulacral spines aborted or absent.

* Disk with very imperfect pseudo-paxillæ. Two innermost supero-marginal plates on each side of the median interbrachial line with small spinelets. Mouth-plates with secondary mouth-spines. Body-frame very thin and delicate .... *hyalinus.*

** Disk with fully developed paxillæ. No spinelets on supero-marginal plates. No secondary mouth-spines. Body-frame robust and rigid .... *inermis.*

†† Supero-marginal plates not united in the median line. A series of small secondary granules behind the ambulacral spines. Cribriform organs very broad and expanded .... *planus.*

HYPHALASTER HYALINUS, n. sp.

Rays five, short, small, rounded, and of uniform thickness throughout. Interbrachial angles of great width, the curve being almost lost in the straightness of the side of the pentagonal disk. The lesser radius is in the proportion of 50 per cent.; $R=20$ millim., $r=10$ millim. The disk, although not high, is more or less inflated. Dorsal area covered with a thin and almost transparent membrane, which is indurated with a great number of spiculate spinelets or pseudo-paxillæ; these consist of a circular scale-like base, from the centre of which a spine-like process rises vertically, and this may be divided into two, three, or four equal spinelets, the latter number being the most general in the centre of the disk and those with one spinelet near the margin. The spinelets are moderately robust, obtuse, all united at the base, and radiating apart very slightly, have more or less the appearance of imperfect paxillæ; whilst the squamous basal plate is scarcely larger than the diameter of the vertical spinous process. These pseudo-paxillæ are rather crowded in the immediate centre of the disk, but are elsewhere moderately and uniformly well spaced. There are no papulæ. The presence of an actual anal aperture is doubtful.

Marginal plates form a perpendicular wall of small but uniform height; the upper margin of the superior series and the lower margin of the inferior series are slightly bent inwards and form bevelled edges. The supero-marginal plates are eight in number, counting from the median interbrachial line, exclusive of the terminal. The innermost plates are nearly twice as long as high, and the outermost are higher than long. The two innermost plates on either side of the median interbrachial suture each bear a single, very minute, conical spinelet near the upper margin and directed horizontally. The two outermost supero-marginal plates extend to the median dorsal line, where they join the corresponding plates from the other side of the ray; the two next plates are separated by a narrow strip of dorsal membrane with pseudo-paxillæ; and the remaining plates fall in the disk-margin. The terminal plate is slightly tumid proximally and tapers rapidly to a fine extremity, which is continued in a robust, sharply pointed terminal spine. This spine, which is longer than the plate, is placed in the median dorsal line of the ray, and is directed outward and slightly upward from the horizontal; two smaller spinelets, less than half the size of the above, are placed at a lower level, one on either side of the extremity of the furrow. The infero-marginal plates correspond in number and breadth with their superior companions; their height is less than the length and varies very slightly throughout the ray. Cribriform organs seven in each angle, very narrow, the outermost almost imperceptible; structure papilliform.

Ambulacral furrows narrow and entirely closed-in by the overarching plates and spinelets. Adambulacral plates large and subcrescentic in form, with the extremities truncate, and the incurved margin directed towards the furrow. Ambulacral spines three to each plate, moderately long, slightly tapering, obtuse, and rather compressed, covered with very delicate membrane, which near the base unites with that of the adjoining spines, and forms a rather broad continuous web, by which the spines are bound together in continuous series. The spines are confined to the adoral or inner two thirds of the plate. Three to five small aborted spinelets, little more than granules, stand upon the surface of the plate behind and external to the furrow-series and form an aborted secondary series. The adambulacral plates are separated throughout the ray from the marginal series by a narrow strip of membrane with scale-like plates continued from the interbrachial area.

Mouth-plates large, prominent along the line of suture, forming a broad well-elevated keel in which nearly the whole of the two plates is involved. The aboral extremity slopes gradually, the surface of the interbrachial area being inclined upward to meet it; and adorally they likewise slope gradually. Sutural junction imperfect, widely expanded aborally, exposing the odontophore. Mouth-spines proper six in each plate, *i. e.* 12 for the whole mouth-angle, the innermost one much larger and more robust than the others; there being thus two large spinelets at the innermost point of each mouth-angle directed over the actinostome. The five smaller spinelets are uniform and equal, less than the ambulacral spines, and are arranged equidistantly along the lateral margin of the plate, and arch over the furrow in continuation of the ambulacral spines. About three aborted secondary spines are placed close to the margin of the plate which falls in the median suture; the middle one is largest, subconical, and stands near the highest point of the keel; the most adoral is similar in shape but rather smaller, and is placed midway between this and the anterior extremity; whilst the outermost one is little more than a tubercular granule, and stands equidistant between the middle spine and the aboral extremity. Occasionally the adoral secondary spinelet is largest. A few irregular rounded granules may occur on the aboral portion of each plate.

The ventral interbrachial area is extensive, covered with a thin transparent membrane and with a compact plating of delicate imbricating scales. The scale-like plates are more or less regularly hexagonal and arranged in columns parallel to the median interradial line. The plates diminish in size and depth towards the margin, where they become narrow elongate strips. Each plate bears 2 or 3 small rounded granules irregularly disposed; the large plates near the interior of the interradial area with a few additional granules in proportion to their size.

Colour, in alcohol, greyish white, with a brownish or slightly orange shade over the dorsal membrane.

Station 274. Lat. 7° 25′ S., long. 152° 15′ W. Depth 2750 fms.; bottom temperature 0°·9 C.; radiolarian ooze.

HYPHALASTER DIADEMATUS, n. sp.

Marginal contour stellato-pentagonal. Rays five, well developed, slender, springing from the disk with a gradual taper, which is continued to the extremity; the upper surface of the ray arched rather than rounded. Interbrachial angles well rounded; the lesser radius is in the proportion of 41·6 per cent.; $R=24$ millim., $r=10$ millim. Dorsal surface of the disk slightly inflated above the level of the marginal plates, and with a prominent conical peak in the centre of the area.

Dorsal area covered with a thick integument, uniformly beset with well-spaced pseudo-paxillæ, which are very small and regular, each carrying 3 or 4 spinelets, those with the latter number being by far the most numerous. The paxillæ do not extend along the rays, but are confined to the actual disk-area; a blank space is thus left at the base of the rays, which has the appearance of being closely plated with small round scales imbedded in the integument. In the neighbourhood of the conical peak the paxillæ become very small and crowded. Around this as a centre and at some little distance away, a number of larger paxillæ made up of more spinelets are arranged; these are congregated with more or less regularity into round groups, of which, roughly speaking, there is one opposite the median line of each ray, with a smaller group intermediate between each of the larger ones. The larger groups consist of ten to twelve large paxillæ of about ten spinelets each; and the smaller groups of about five or six paxillæ. Outside this conspicuous ring of the disk there are a few large paxillæ placed here and there amongst the general small or pseudo-paxillæ of the disk.

Marginal plates, instead of forming perpendicular rounded sides, are inclined inwards towards the centre, which gives a bevelled edge to the disk and an arched rather than a rounded character to the upper surface of the rays. The supero-marginal plates do not meet in the median line of the ray, but leave a rather wide suture along the whole length, which expands on approaching the disk. All the marginal plates are longer than high, excepting perhaps the penultimate superior. The superior series are ten in number exclusive of the terminal, and vary in depth very slightly from the arm-angle to the extremity of the ray. The inferior series correspond in number and breadth with the superior series, but diminish gradually in height as they proceed along the ray. The surface of the plates is perfectly smooth, and forms an even contour-line to the ray, the sutures being hardly discernible except with magnifying-power. None of the supero-marginal plates bear spines except the terminal. This plate is comparatively small and inconspicuous, subtriangular in contour, and upturned at a sharp angle from the plane of the ray, a position that gives a very marked character. It bears three rather short robust spines—one, which is somewhat the stoutest, is placed in the median dorsal line and directed vertically upwards; the other two stand at the anterior ventral angles of the plate, and are directed outward and at an angle of about 45° to the single spine. In consequence of the thinning-off of the terminal plate, the bases of these lateral spines are not far removed from that of the dorsal spine; a deep indentation or sinus occurs between them, in which the ambulacral furrow terminates. Cribriform organs five in each angle, rather wide, and leave only a small band of the plate between adjacent organs; each with a depression down the median line; structure papilliform.

Ambulacral furrows deep and contracted; the adambulacral plates arching considerably over, and the ambulacral spinelets covering-in the area when disposed for that purpose. The adambulacral plates are elongate and subcrescentiform, and each forms an angular prominence on the sides of the furrow, the angles separating to a certain extent the sucker-feet of neighbouring segments. Ambulacral spines four to each plate, short, thin and compressed, uniform in breadth throughout and rounded at the extremity, arranged in a straight, or sometimes slightly curved, line and at a very slight angle to the furrow, the direction of the line being outward from the furrow. A secondary row of 5 or 6 small granules stands on the outer margin of the adambulacral plates behind the furrow-series, placed in a slightly curved line; and these become more or less indistinct along the outer portion of the ray.

The mouth-plates are large, prominent, and elevated along the line of suture; the junction is imperfect, and the aboral extremities of the plates being widely open, expose the odontophore. Mouth-spines 6 to 8 on each side, short, compressed and pointed: the innermost one on each side larger and longer than the rest, and directed towards the actinostome; the lateral ones falling into the furrow and interlocking with the corresponding denticles of the neighbouring mouth-angle. A number (varying from 6 to 12) of small granule-like tubercles are present on the superficies of each plate; two, which are slightly largest, stand near the inner third of the plate; whilst the remainder are confined to the aboral half of the plate, and are sometimes arranged in two or three lines and sometimes irregularly. It seems scarcely possible to rank these as secondary mouth-spines; and yet there can be little doubt that they are rudimentary or aborted representatives of these appendages.

The ventral interbrachial areas are triangular in outline, and covered with a regular plating of hexagonal imbricating scale-like plates arranged in columnar series extending from the margin to the furrow parallel with the median interbrachial line. The plates are broader than long, the disproportion increasing as they approach the margin; they bear a few (3 to 5) small, widely-spaced, irregularly disposed granules, some plates here and there having none.

Colour, in alcohol—margins and actinal area greyish white; dorsal membrane bluish grey, with touches of light brown near the margin of the area and occasionally on the groups of paxillæ round the centre of the disk.

Station 299. Lat. 33° 31′ S., long. 74° 43′ W. Depth 2160 fms.; bottom temperature 1°·1 C.; grey mud.

Hyphalaster inermis, n. sp.

Marginal contour stellato-pentagonoid. Rays five, well developed, slender, round, and tapering but slightly. Interbrachial angles very wide and expansive, the curve slightly flattened in the immediate angle, thereby emphasizing the marked pentagonal contour of the body-disk. The lesser radius is in the proportion of 42·5 per cent.; $R=20$ millim., $r=8{\cdot}5$ millim. Disk depressed, not inflated; both dorsal and actinal surfaces stand on a level with the edges of the marginal plates.

Dorsal area covered with closely crowded paxillæ, the whole disk as well as the base of the rays being uniformly packed. The paxillæ are very fine and small, and are made up of about 5 to 10 spinelets; towards the margin of the disk they become smaller and also in the centre, where they are very compact, a slightly prominent peak being formed as in *Ctenodiscus*. A slight elevation of the surface is present in the median radial line, opposite the base of each ray, and at about one third of the distance from the margin to the centre.

Marginal plates occupy the entire margin and represent the whole thickness of the animal, forming perpendicular walls regularly rounded above and below. Along the rays the supero-marginal plates meet in the median dorsal line and form a complete casing to the ray, which is well rounded, small, and tapers but slightly. The supero-marginal series are 8 in number (or, with a very small aborted one, 9), exclusive of the terminal. The plates which fall in the margin of the disk proper have the length about equal to their height, but in those along the ray the height is greater than the length. The infero-marginal plates correspond in number and in length with the superior series. In the arm-angle, along the disk proper, the height is about equal to the length and the plates are uniform in size with the superior series; towards the extremity of the ray the height diminishes gradually and the length is greater than the height—a reversal of the relative proportions presented by the plates of the superior series. The marginal plates are smooth and bear no spines, but when examined microscopically have the appearance of being subgranular and built up of a rather open network. The plates of both series are convex outwardly or tumid in a very slight degree, by which means the sutural divisions of the segments are clearly marked out, and a somewhat annulated appearance is given to the ray. The terminal plate is large and conspicuous, appearing somewhat tubercular and directed slightly upwards when viewed in profile, and oval in contour when seen from above. This plate bears three short and rather robust spinelets—one at the terminal extremity of the plate, situated in the median dorsal line, pointing in the direction of the prolongation of the ray, and diverging but little from the horizontal. Below this spine, and at either side of it, at the angle formed by the ventral edge of the plate and the terminal extremity, is a somewhat smaller spinelet, pointing in the direction of the prolongation of the ventral margin of the plate. Cribriform organs 7 in number, narrow and well defined; structure papilliform.

Ambulacral furrows narrow and straight, almost completely closed-in by the overarching adambulacral plates and spines, the sucker-feet, which are arranged in simple pairs, being entirely concealed from view. The adambulacral plates are about half as broad as long, but diminish in size as they proceed outwards; and form along the ray triangular prominences projecting into the furrow. Each plate bears 3 to 4 spines, rather short, rapidly pointed, more or less compressed, invested with membrane, arranged in line along the furrow-margin of the plate and sometimes slightly oblique to the course of the furrow. The row of spinelets can be raised at a right angle to the surface of the plate, so as to allow the sucker-feet to be protruded. Traces of an aborted secondary or external spinelet, represented by a mere granule, may be detected at the adoral extremity of the adambulacral plate, away from the furrow-series.

Mouth-plates moderately large, the inner margins which fall in the median suture being elevated so as to form a rounded elongate tubercular protuberance, the lateral margins being flattened out. Mouth-spines 7 or 8 on each side, similar to the ambulacral spines, excepting the innermost one, which is much larger and stouter. Two large spines are thus conspicuous at each mouth-angle and are directed towards the centre, the series entirely closing the peristome, which is remarkably small. The small mouth-spines upon the margin of the plate interlock with those of the adjacent mouth-angle, and form a continuous series with the ambulacral spines. The rudiments of a secondary mouth-spine, represented by a thorn-like granule, occur on each plate near the median suture and at the highest portion of the keel.

The interbrachial areas are triangular in outline, flat, extensive, and covered with imbricating scales of more or less regularly symmetrical hexagonal form. These plates are broader than long, and arranged in regular series of single columns extending from the margin of the disk to the ambulacral furrow; their breadth diminishes somewhat as they approach the margin, and consequently that of the column also. The adambulacral plates join up to the infero-marginal plates along the whole length of the free portion of the ray, and there is consequently no extension of the interbrachial area along the ray. The imbricating plates bear a few widely-spaced miliary tubercles or large granules upon their surface, usually 4 or 5 to a plate, but upon which they have no definite arrangement.

Colour, in alcohol, grey, the paxillar area being a much darker shade, which shows a strong contrast with the greyish white of the marginal plates.

Station 237. Lat. 34° 37′ N., long. 140° 32′ E. Depth 1875 fms.; bottom temperature 1°·7 C.; mud.

HYPHALASTER PLANUS, n. sp.

Marginal contour stellato-pentagonoid. Rays five, of moderate length, and comparatively slender from the disk outwards. Interbrachial angle very wide, more or less flattened, giving a strongly marked pentagonal aspect to the large disk. The lesser radius is in the proportion of 42 per cent.; $R=35$ millim., $r=15$ millim. Disk depressed and not higher than the supero-marginal plates, although apparently capable of a slight inflation.

Dorsal area covered with small, closely crowded paxillæ, which are limited to the disk proper and extend very slightly onto the base of the rays, the median dorsal line of the ray being covered with membrane beset with small squamiform plates. The paxillæ are small and composed of 4 to 6 short and comparatively robust spinelets, and so closely placed as to almost give the appearance to the disk of being coarsely granulated, when seen without a magnifier. A prominent conical anal protuberance is present in the centre of the disk.

The marginal plates constitute the entire thickness of the animal, and form a well-rounded margin to the disk. Along the rays the supero-marginal plates of the opposite sides do not meet, but are separated throughout the whole extent of the ray by a median dorsal membranous area beset with squamæ. The rays are comparatively slender and well rounded, having a cylindrical appearance, and proceeding somewhat abruptly from the angles of the disk. The supero-marginal plates are 10 or 11 in number, exclusive of the terminal ocular plate; they are rather longer than high, excepting in the one or two outermost plates, where the proportions may even be very slightly reversed. The infero-marginal plates correspond with the superior series, the length exceeding the height throughout the ray. The height of the plates of the inferior series is greater in the angle of the disk than that of the superior series, whilst along the ray it is much less, and it is less also than one half the length of the plate. There is a gradual, but very striking, diminution in the size of the plates of both series as they pass from the disk along the ray. The marginal plates are smooth and covered with a very fine membrane; all devoid of spines excepting the terminal ocular plate. The terminal plate is not large or conspicuous, its size being in serial proportion to the neighbouring supero-marginal plates, and forms a blunt obtusely rounded extremity to the ray, whilst its ventral portion is slightly curved upwards. It bears 3 spinelets or representatives of such appendages—one, which is short, robust, and conical, placed at the extremity in the median dorsal line and directed vertically; and a pair, one placed on either side, at a lower level but quite in front of the dorsal spine. The laterals are probably aborted, being, at least in the specimen under notice, little more than tubercles. Cribriform organs 7 in each angle, very widely expanded, covering nearly the whole of the plates, adjacent organs almost touching in the neighbourhood of the horizontal suture; structure papilliform.

The ambulacral furrows are narrow, and when contracted and closed-in by the spinelets the sucker-feet are entirely hidden from view. The adambulacral plates are elongate and subrhomboid in form, and present an angular prominence towards the furrow, the adoral side of the angle being much shorter than the aboral; from this circumstance results a singularly elegant festooned appearance when the furrow is viewed as a whole.

Ambulacral spines four in number, except close to the mouth, three being placed on the aboral facet of the furrow-margin of the plate, and one on the short adoral facet. The three innermost plates of the furrow immediately succeeding the mouth-plates have 5 or 6 spines, and the angular prominence into the furrow is less pronounced. The ambulacral spines are uniform in size and shape throughout the ray; they are small, short, flat, and terminated abruptly with a lanceolate point, and all are in connexion at their base with the common investing membrane of the plate. Behind the inner or furrow-series of ambulacral spines are 3–5 small granules, arranged in a slightly curved line, which appears to follow the rounded margin of the adoral extremity and the outer side of the adambulacral plate. The most adoral of these granules show a tendency to develop the flat and pointed form of the ambulacral spines; and there is little doubt that they are the representatives of an outer or secondary series.

Mouth-plates large and prominent, each curving down coulter-form until the margins which fall in the median line are at right angles to the plane of the actinal surface. The prominent median keel thus produced slopes with a regular curve ad- and aborally, its longitudinal profile being almost semicircular. The median suture is not closed, but rather widely open, and expands towards the aboral extremity of the plates and exposes a portion of the odontophore. Each plate bears a short, robust, conical, pointed spine at its innermost extremity, the companion spine of the adjoining plate standing parallel. There is thus a pair of short, but conspicuous mouth-spines directed towards the centre of the peristome from each mouth-angle. The remaining mouth-spines are 6 in number and are uniform in size and shape with the ambulacral spines, and are arranged along the margin of the plate which abuts on the furrow. A few prominent granules are present on the surface of the mouth-plates, but do not, in the specimen under description, appear to be arranged in any definite order.

The ventral interbrachial areas are large and extensive, flat, and covered with oblong squamiform plates. On the outer portion of the area these plates are about twice as broad as long, and are arranged in columns parallel with the median interradial line. In the neighbourhood of the mouth-angle and adjoining the adambulacral plates the ventral plates become larger and altered in form and appear independent of the column-series. The ventral area is covered with a very fine and almost imperceptible membrane, plates and membrane together being so thin that traces of the internal organs of the starfish can be seen through them. A number of small irregularly disposed granules are distributed over the area, but seldom more than 2 or 3 on a plate, and often wanting. The imbrication of the plates appears to be very slight in this species, and is perhaps only present in the outer part of the areas.

Colour, in alcohol, grey, with traces of a purple shade remaining here and there upon the paxillar area and on the rays.

Station 157. Lat. 53° 55′ S., long. 108° 35′ E. Depth 1950 fms.; diatom-ooze.

THORACASTER, n. gen.

Rays five, moderately long, cylindrical, and rigid. Disk large. Superomarginal plates united in the median dorsal line and form a cylindrical encasement to the ray. Marginal plates devoid of spinelets. Abactinal area covered with small, closely crowded paxillæ. No central epiproctal protuberance. Actinal interradial areas extensive, paved with plates imbedded in membrane, and carrying numerous, small, uniform, rather closely placed papilliform granules or spinelets. Ambulacral furrows narrow and enclosed. Ambulacral spines short, equal, ranged on the furrow-margin of the plate and forming a lineal series along the ray. Outer portion of the adambulacral plates occupied by small papilliform spinelets more or less definitely arranged. Cribriform organs 14 in number in each interbrachial angle, in the single species known. Terminal plate small, inconspicuous, and unarmed.

THORACASTER CYLINDRATUS, n. sp.

Marginal contour stellate, with large disk and five very narrow cylindrical rays which taper to a point. Interbrachial angle very wide and well rounded. The lesser radius in the proportion of 33·8 per cent.; $R=62$ millim., $r=21$ millim.

Disk slightly inflated, forming a convex surface of low curvature. The dorsal area is covered with very small, compact, and closely crowded paxillæ, which are, however, confined entirely to the disk, in consequence of the junction of the supero-marginal plates in the median line along the whole of the free portion of the ray. The paxillæ are very small and composed of 6–10 small spinelets closely appressed into a fascicule, the whole area appearing to the unaided eye almost like a uniformly granular surface. The paxillæ are a shade smaller in the centre of the disk, which they further define by their arrangement, although no prominent anal peak is produced. The actinal area of the disk is slightly convex and slopes downwards at a small angle to the prominent mouth-plates.

The marginal plates are high, forming a gently rounded margin to the disk, the plates curving slightly inward towards the dorsal and the ventral areas respectively. When viewed from above they are seen to encroach on the dorsal area to a very slight degree, and still less on the ventral. Along the free portion of the ray the supero-marginal plates of the two sides of the ray meet in the median dorsal line and entirely encase the ray; in consequence of the regular rounding of the plates, the ray assumes a perfectly cylindro-conical form, tapering to the tip, and suggesting the appearance of a delicate belemnite.

The supero-marginal plates are 43 or 44 in number, counting from the tip of one ray to the tip of the neighbouring ray, exclusive of the terminal odd plates, the odd number arising from a marginal plate being placed in the median interbrachial line, instead of a sutural division as usual in *Porcellanaster*. All the marginal plates are devoid of spines or tubercles; and in both the superior and inferior series the height is greater than the length, throughout the ray. The infero-marginal plates correspond exactly with the superior series, and their height may also be said to be equal. A few very small conical granules, evidently loosely attached, are present on the surface of the marginal plates, especially on those which border the disk, and chiefly grouped near the ventral margin of the infero-marginal plates and the dorsal of the superior series. The terminal plate is very small and inconspicuous, in no way gibbous or exceeding the natural conformity as tip of the tapering ray, and is entirely devoid of spines. Seen in lateral profile, the tip of the ray shows a very faint tendency to an upward curve, produced by the slightly elevated position of the terminal plate and the curving upward of the ventral area. Cribriform organs 14 in each angle, very narrow; structure papilliform.

The ambulacral furrows are narrow, and when in a state of contraction entirely conceal the sucker-feet. The adambulacral plates are longer than broad, but are quite inconspicuous, their form and even the divisional sutures being masked by the membrane and spinelets with which they are covered. Along the furrow-margin of the plate are 5 ambulacral spines, and the series of these form a continuous straight line throughout the ray, without curve or break of any kind. These spines are short, robust, truncate at the extremity, and flat, their breadth being placed at right angles to the furrow, and all are equidistantly spaced apart. Behind the furrow-series each adambulacral plate bears two irregular series of smaller and subconically shaped spinelets, about three standing at irregular distances next to the inner spinelets, and about five in the outer series. Owing to the irregularity of number and position and their tendency to group, these outer spinelets do not form the definite continuous lineal series presented by the inner or furrow-series of ambulacral spinelets.

Mouth-plates large, and the combined pairs form conspicuous tubercular prominences. The median suture is imperfectly closed and expands at the aboral extremity of the plates, exposing the odontophore. Along the free horizontal margin of the plate range a series of 6 or 7 mouth-spines similar to the ambulacral spines, the innermost being slightly largest. The surface of the plate bears a number of spiniform granules, which are most robust and elongate on the adoral half of the plate. Beyond this these appendages do not appear to present any special arrangement or to form definite series; and they impart a very echinulate aspect to the mouth-angles.

The ventral interbrachial areas are large and covered with membrane and minute, subspiniform, conical granules; these are small, very numerous and rather closely placed, and distributed over the whole area, here and there with a faint appearance of grouping, which seems to suggest the indication of the separate ventral plates. Of the actual outline, arrangement or character of these plates no observations can be made, owing to the uniform and thick covering of membrane with which they are overlaid.

Colour, in alcohol, yellowish white, the paxillar area having a rather browner shade.

Station 89. Lat. 22° 18′ N., long. 22° 2′ W. Depth 2400 fms.; bottom temperature 1°·8 C.; *Globigerina*-ooze.

Family Astropectinidæ.

Astropecten, *Linck*.

Synopsis of Species herein enumerated.

A. With two series of definite spines on the supero-marginal plates.
  † Three marginal spines. Ambulacral spines, three in the inner series, and three also in second series, the aboral largest. . . . . *brasiliensis.*

†† One marginal spine. Ambulacral spines 4 or 5 in the inner series; outer part of plate occupied by a group of papilliform and equal-sized spinelets.... *brevispinus.*

B. With one series of definite spines on the supero-marginal plates.

† With large, prominent spines on the supero-marginal plates.

* With large well-developed spines on the infero-marginal plates. No naked spaces .... *polyacanthus.*

†† With small spines on the supero-marginal plates.

* The series of supero-marginal spines continuous throughout the ray.

1. Marginal spines 4 in an oblique comb. Ambulacral spines in 3 series, 3 in each.......... *pectinatus.*
2. Marginal spine 1, long and cylindrical, with 2 small companions close behind. Ambulacral spines of the second and third rows frequently grouped, normally 3 in each. A spine on the infero-marginal plate near the adambulacral plates.................................... *acanthifer.*

** The series of supero-marginal spines not continuous throughout the ray.

|| Wanting in the interbrachial angle.

o. Marginal spine 1. Ambulacral spines in 3 series............................. *japonicus.*

|||| Wanting on the outer half of the ray, but continuous in the interbrachial angle.

o. Marginal spines 3. Ambulacral spines in 2 series.............................. *imbellis.*

C. With only an indefinite spinelet, or several enlarged granules on the supero-marginal plates.

† With 3 ambulacral spines in the second series.

* Marginal spine 1. Outer ambulacral spines very broad and flaring. No aboral line of spinelets on the infero-marginal plates............... *hermatophilus.*

** Marginal spines 4 or 5 in diagonal line. Outer ambulacral spines short, not broad or flaring, placed diagonally. An aboral line of spinelets on the infero-marginal plates..................... *pontoporæus.*

D. With no spinelets on the supero-marginal plates; excepting in some species a very small one on the first or first 4 or 5 in the arm-angle.

† With small spinelets on the first 4 or 5 plates.

* With 4 or 5 spinelets. A well-developed series of pseudo-pedicellariæ........................ *zebra.*

** With 1 spine only, on first plate. No pedicellariæ.................................... *velitaris.*

†† With no spines whatever on the supero-marginal plates.

* Marginal spines 1.

With 2 or 3 ambulacral spines in the second series.

1. Supero-marginal plates broad, with small granules. Paxillæ with 5–8 granules (or spinelets) on the central tabulum ...... *granulatus.*
2. Supero-marginal plates narrow, with large granules. Paxillæ with one granule on the central tabulum .... *monacanthus.*

** Marginal spines 2, side by side.
Infero-marginal plates covered with squamules.
An aboral line of spinelets present. Marginal spines taper and pointed. Supero-marginal plates very broad .... *cingulatus.*
*** Marginal spines 4, in an oblique line.
Ambulacral spines all cylindrical and taper.
Infero-marginal plates with papillose spinelets rather than squamules. No aboral line of spinelets. Supero-marginal plates not very broad. *mesactus.*

ASTROPECTEN BRASILIENSIS, *Müller & Troschel.*

Station. Off Bahia. Depth 7–20 fms.

Station. Off Fernando Noronha. Shallow water.

ASTROPECTEN BREVISPINUS, n. sp.

Rays five. $R=3{\cdot}2\,r$; $R=32$ millim., $r=10$ millim. Rays tapering regularly from the base to the tip and terminating in a point. Breadth of a ray at the base about 11 millim. Interbrachial angles slightly rounded.

Supero-marginal plates 22 in number from the interbrachial line to the tip, higher than broad along the inner half of the ray, but broader than high on the outer portion. Each plate (excepting two or three in the arm-angle and a few at the extremity) bears two small, conical, sharply pointed spines. The inner series are placed close to the inner edge of the plate, and are continuous from the arm-angle until near the tip, decreasing in size as they proceed outward, until they disappear altogether. The outer series are slightly larger, and are placed at the extreme edge of the plate on the rounding where the dorsal and lateral superficies converge; they are continuous throughout the ray, excepting the innermost plate in the arm-angle.

Infero-marginal plates higher than broad, and flush with the superior series. Each plate bears a single marginal spine, short, tapering continuously from base to tip, sharply pointed and slightly compressed. On the inner half of the ray, two similar and slightly smaller spines are situated on the median line of the plate—one, which is the smallest, not far from the inner edge of the plate adjoining the adambulacral plates, and the other about midway between this spine and the marginal spine, the three forming a lineal series transverse in relation to the direction of the ray. On the outer portion of the ray the inner spine is aborted or indistinguishable from the squamules of the plate. When the side or lateral wall of the ray is placed in direct view, the above-mentioned spines of the inferior plates are all visible, and they, together with the spinelets of the superior plates, appear to form a continuous vertical series. The marginal spine is very little, if at all, longer than the outer spine on the supero-marginal plate, and all these spines stand at an angle to the superficies of the plate and are directed upward and outward. Very short, widely spaced, papilliform squamules are distributed over the whole of the infero-marginal plates, and the granulation of the supero-marginal series partakes of the same character and is indistinguishable at the junction of the plates.

The ambulacral spines are short and robust, subpapilliform, and do not taper, and they stand more or less perpendicular to the surface of the plate. The inner series are 4 or 5 in number, and their base-line forms a slight angle projecting into the furrow; the middle spinelets are a shade larger and more robust than the others. The ambulacral spinelets that occupy the rest of the plate behind the furrow-series are little more than elongate papillæ; they are small, stumpy, covered with membrane, and are rather widely spaced, no definite order of arrangement being discernible, although about two irregular rows may be traced in some instances. The spinelets on the ventral plates are similar in character and disposition to the foregoing, and they merge imperceptibly into the squamules of the infero-marginal plates. This uniformity in the dermal appendages imparts a characteristic appearance to the ventral aspect of the starfish.

Mouth-plates elongate, each with two short, flattened, truncate spinelets at the inner extremity, then about six pairs of spinelets, short and robust, standing perpendicular on the surface of the plate and forming two series apposed to one another; and then about four rather broader, shorter, and more robust spinelets, forming a single series in continuation as it were of the two apposed series, at the outer extremity of the plate, towards which the spinelets decrease as they proceed outward. Consequent on this method of arrangement there is a marked division of the mouth-plate armature into two narrow series along the median line of each mouth-angle.

The paxillæ of the dorsal area are small and compact, and composed of six to nine spinelets, of which one is central. The spinelets are short and robust, and are directed upward, their radiation apart being very slight. No definite order is maintained in the arrangement of the paxillæ. The papulæ are small and dark brown, or almost black in colour, and a broad space occurs along the median line of the ray in which none are present. In the centre of the disk there is a large, conspicuous, and well-developed conical prominence, upon and in the neighbourhood of which the paxillæ are greatly reduced in size. No anal puncture is traceable.

The madreporiform body is small and situated at about one third of the distance from the margin to the centre of the disk. The terminal (ocular) plate, though small, is conspicuous and elongately oblong.

Colour, in alcohol, umber-brown, becoming lighter in shade towards the extremities of the rays. The spinelets white. Small specimens yellowish white.

Station 232. Lat. 35° 11′ N., long. 139° 28′ E. Depth 345 fms.; bottom temperature 5°·0 C.; sandy mud.

Astropecten polyacanthus, *Müller & Troschel.*

Station. Port Jackson, Australia. Depth 2–11 fms.
Station. Admiralty Island. Depth 16–25 fms.
Station. Yokohama, Japan. Depth 5–25 fms.
Station. Kobi, Japan. Depth 8–50 fms.

Astropecten pectinatus, n. sp.

Rays five. $R < 3{\cdot}5\,r$; $R = 48$ millim., $r = 14$ millim. Rays broad at the base, tapering continuously to the extremity, which is finely pointed. Breadth of a ray at the base 16·5 millim. Interbrachial angle subacute or very slightly rounded.

Supero-marginal plates 21 in number from the interbrachial line to the tip, higher than broad, the disparity being greatest in the arm-angle and diminishes towards the extremity. When seen abactinally the plates have the appearance of being slightly oblique in relation to the direction of the ray, and each, excepting the two innermost, is slightly convex or submammillate at the outer angle formed by the junction of the dorsal and lateral superficies of the plate, which falls in the marginal contour of the ray. On the summit of this convexity is borne a small short conical spinelet; and although normally the series of spinelets is continuous throughout the ray, a plate occasionally occurs on which the spine is wanting. The two inner supero-marginal plates are narrower dorsally than the others, and the spinelets they bear are slightly longer and more robust.

The infero-marginal plates are broader than high, and do not extend laterally beyond the superior series. Each plate bears an oblique comb of four marginal spines, their line of base forming an angle of about 45° passing from the adoral side to the aboral side of the plate. The adoral spine is the smallest and the most outward, and the third from the margin the longest, the second is intermediate in size, and the fourth nearly as long as the third. A fifth and much smaller spine is situated on the aboral side of the plate a little distance from the comb or marginal series; and in the inner portion of the ray one or even two similar isolated spines may be present on the aboral side of the plate in lineal series. All these spines, as well as the marginal series, are elongate, delicate, cylindrical, and taper to a fine point; and the marginal spines are very slightly bent. The whole of the surface of the infero-marginal plates is compactly covered with small, flat, roundly tipped squamules, uniform and closely placed.

The ambulacral spines are arranged in three distinct series, three spinelets in each. The inner series are of moderate length, the middle spine being slightly longest, subcylindrical, and slightly tapering, whilst the companion spinelets are often slightly flattened. The second series consists of three equal spinelets, which are shorter than the inner series, and are flat and expanded towards the tip, which is roundly truncate. The outer series, likewise of three spines, are similar to those of the second series, the middle spinelet, however, being usually broader and more flaring than the companions; occasionally there may be an additional small spine present in this series. The inner series are directed more or less over the furrow; the second series are usually perpendicular; and the outer series are directed outward towards the margin of the ray. There is also a tendency in the spinelets to radiate apart. Consequent on this mode of arrangement, the armature of the adambulacral plates has a very widely expanded character on the whole.

The ventral plates are small and very few in number, and confined to the immediate interbrachial area. The spinelets that cover them are small, more or less subspatulate in form, and radiate apart.

The mouth-plates are of moderate size, each pair forming a subtubercular prominence; the whole surface covered with small robust papilliform spinelets, forming two or three lineal series on each plate. These spinelets increase in length towards the inner extremity, the innermost ones not being greatly longer or more prominent than the rest.

The paxillæ of the dorsal area are large and uniform, and are arranged in regular transverse lines which extend up to the median line of the ray. The paxillæ have a large tabular surface on which are placed twelve to fifteen short papilliform spinelets, and the periphery is surrounded by about an equal number of similar spinelets. In the centre of the disk the paxillæ are smaller, and are very compactly placed. There is no trace of any anal puncture, and no protuberance in the centre of the disk.

The madreporiform body is very small, and is situated at about one third of the distance from the margin to the centre, and sometimes rather further away from the margin even than this. In some specimens there is a faint depression along the median line of a ray; and in large examples a similar slight sulcus occurs on the outer portion of the median interbrachial line.

Colour, in alcohol, a light purplish shade, of which only a trace remains in some specimens, the rest being almost ashy white.

Station. Port Jackson. 6–15 fms.

Station 161. Off entrance of Port Philip. Depth 38 fms.; sand.

Station 162. Off East Moncœur Island, Bass Strait. Depth 38–40 fms.; sand.

Astropecten acanthifer, n. sp.

Rays five. $R > 6{\cdot}5\,r$; $R = 90$ millim., $r = 14$ millim. Rays elongate and tapering; disk very small. Breadth of a ray at the base 14·5 millim.; interbrachial angles acute. Supero-marginal plates rather higher than broad, 43 in number from the interbrachial angle to the tip. Each plate bears on the outer dorsal margin (or rounding that falls in the marginal contour) a single, small, delicate, conical, and sharply pointed spine. The series is continuous throughout the ray; and the two innermost spinelets are rather more robust than the others.

Infero-marginal plates broader than high, and do not extend beyond the superior series. Marginal spines three, close together in transverse series: the outermost, or marginal spine proper, is long, delicate, cylindrical, tapering to a sharp point, and slightly bent; the second, which stands immediately behind, is about two thirds the length and precisely similar; the third spine is very small, not more than one third the length of the preceding, and is hardly worthy of being ranked as a marginal spine. Sometimes a small spinelet similar to the last mentioned stands by the side of the second marginal spine. No other spinelets are present on the infero-marginal plates excepting a single isolated spinelet in the median line and near the inner end of the plate adjacent to the adambulacral plates. This spinelet is cylindrical, taper and sharply pointed, and somewhat longer and more robust than the third marginal spine; its presence and isolation gives a very characteristic appearance. The surface of the infero-marginal plates is covered with small and not very closely crowded papilliform squamules, which increase slightly in length and robustness at the inner end of the plate near the adambulacral plates.

Ambulacral spines not very large or prominent. Innermost furrow-series three in number, delicate, cylindrical, taper; the middle spine slightly more prominent in the furrow than its companions. Outer spinelets difficult to formulate, in consequence of irregularity in their mode of arrangement. Normally a second and an outer series are present, having about three spinelets in each; but these are often placed in such a way as to appear to give two to the second series and four, arranged diamond-wise, to the outer series; frequently, also, one or two small additional spinelets may be present, usually in the latter series, which then forms a group. The second series are shorter than the inner series, and are slightly compressed and faintly subspatulate. The outer spinelets are shorter than the preceding and are not flattened; their length near the middle of the ray is very slightly in excess of the length of the papilliform squamules of the adjacent ventro-marginal plate. Very few ventral plates are present, and bear spinelets similar to the outer ambulacral spines, and these are usually grouped together into an incipient pedicellaria (?).

Mouth-plates elongate, and covered with comparatively long, closely-placed spines, which are flattened and more or less subspatulate. The two inner spinelets, placed side by side on each plate, are longer and larger than the rest; and these, together with their smaller lateral companions, form a horizontal comb of 6–8 spinelets directed towards the centre of the mouth. Behind these inner spinelets follow two or three shorter spines in lineal series on the surface of the plate; and these are succeeded by 8 or 9 pairs of short flat spines, closely placed and occupying the middle portion of the surface, on which they stand perpendicular; and the outer part of the plate carries 3 or 4 spines in single line directed outward, their length and robustness increasing as they recede from the mouth. The next adambulacral plate to the mouth-plates is narrow, and the spines thereon are small, uniform, and arranged in two single lineal series apposed to one another.

The paxillæ of the dorsal area are large and form a compact surface. Each consists of four or five short granuliform spinelets in the centre of the tabulum surrounded by a circle of a dozen or more short delicate obtuse spinelets, the central four having a rather isolated appearance within the circle. A very large conical prominence is present in the centre of the disk. The madreporiform body is obscured by paxillæ.

The ambulacral sucker-feet are small and terminate in a point, which is tipped with black and gives a very singular appearance to the species.

Colour, in alcohol, yellowish grey.

Station 192. Lat. 5° 42′ S., long. 132° 25′ E. Noon. Depth 129 fms.; mud.

Astropecten japonicus, *Müller & Troschel.*

Station. Off Yokohama, Japan. Depth 8–14 fms.; 5–25 fms.

Station 233 a. Kobi, Japan. Lat. 34° 35′ N., long. 135° 10′ E. Depth 8–50 fms.; mud, sand.

Station 233 b. Lat. 34° 20′ N., long. 133° 35′ E. Depth 15 fms.; mud.

Astropecten imbellis, n. sp.

Rays five. $R<3\cdot5r$; $R=24$ millim., $r=7$ millim. Rays rather narrow, especially on the outer part, tapering continuously from the base to the extremity. Breadth of a ray at the base about 7 millim. Interbrachial angles subacute.

Supero-marginal plates 18 in number from the interbrachial angle to the tip, about as broad as high, but higher in the inner part of the ray. The plates are slightly tumid, and form a well-rounded margin to the ray. The surface of the plates is covered with very fine, closely-placed, papilliform granules; and the 8 or 9 innermost supero-marginal plates bear a small, delicate, sharply pointed spinelet about equal in length to the length of the plate, and placed near the middle of the dorsal portion of the plate. The breadth of the plates is very little greater than the length on the inner portion of the ray; and on the outer portion these proportions are reversed.

Infero-marginal plates broad, gently rounded on to the actinal surface, and do not extend beyond the superior series. Marginal spines 3, placed close together in a very oblique series, the second from the margin being slightly longest and most robust; all are exceedingly delicate, needle-like, and very faintly bent, the longest being rather more than twice the length of the plate. On the three innermost plates the upper or outer spine is the longest; it is also flattened and much broader than elsewhere. Excepting on the three innermost plates no other spines occur; on these, however, one or two very small ones are present in the median line. The surface of the infero-marginal plates is covered with numerous minute papilliform squamules closely placed, which become more spiniform towards the margins. Ventral plates not more than two or three present, covered with short papilliform spinelets similar to those just noticed.

Ambulacral spines short, delicate, cylindrical, slightly tapering at the tips, forming two series. The inner series consists of three spines; the middle slightly longest, radiating apart and directed over the furrow. The outer series consists likewise of three similar and equal spinelets usually directed towards the margin of the ray; and occasionally there may be one or two supplementary spinelets, usually smaller, and almost indistinguishable from the spinelets of the infero-marginal plates; occasionally one is as large as the three spinelets of the outer series, and is irregular in position.

Mouth-plates small, and form a prominent narrow keel along the median suture-line, on either side of which are borne two rows of rather elongate cylindrical spinelets, 6 or 7 in each, and 2 or 3 in single series on the outer part, which are larger. The innermost spinelets are more robust than the others, but only very slightly longer, and no prominent horizontal comb is formed over the mouth-opening as in other species. There is a row of 5–7 rather elongate spinelets on the free margin of the mouth-plate.

The paxillar area has a comparatively open and irregular appearance in consequence of the character of the paxillæ; these have short thin pedicels scarcely forming a true tabulum, and are surmounted by 8–10 rather long delicate spinelets, much longer than the pedicel, and do not usually radiate apart widely. In consequence of the rather wide separation of the paxillæ, a somewhat "draggled" appearance is produced. In the centre of the disk the paxillæ are rather smaller and more crowded, and a central prominence is present.

Madreporiform body small, and almost concealed by paxillæ, situated rather more than its own breadth from the margin.

Ambulacral sucker-feet moderately robust and with conical pointed tips.

Terminal (ocular) plate rather large, and broader than long; distinctly appearing as if formed by the lateral union of two semicylindrical plates, with a rather large tubercular granule on either side at the extreme tip, on which spinelets were probably articulated.

Colour, in alcohol, yellowish grey, with a darker tint over the paxillar area approaching greenish grey.

Station 204. Lat. 12° 43′ N., long. 122° 10′ E. Depth 100–115 fms.; mud.

ASTROPECTEN HERMATOPHILUS, n. sp.

Rays five. $R>3r$; $R=25$ millim., $r=8$ millim. Rays of moderate breadth, tapering from the base to the extremity, but do not become attenuate or sharply pointed. Breadth of a ray at the base 8·5 millim. Interbrachial angles slightly rounded.

Supero-marginal plates 22 or 23 in number from the interbrachial line to the tip, slightly broader than long; height greater than length, and increasing on the inner portion of the ray, where it is greater than the breadth. The plates are slightly tumid and well defined; and are covered with low rounded granules, which are larger and more prominent in the middle of the plate. Normally each plate bears a prominent spiniform granule on the rounding between the dorsal and lateral surfaces; and occasionally a second may be present close beside it. Usually one or two of the innermost plates on either side of the median interbrachial line carry two of these spiniform granules, of equal size.

The infero-marginal plates do not protrude beyond the line of the superior series, and are gently rounded on to the actinal area. Each plate has a single, short, slightly compressed, and sharply tapering marginal spine, followed by two similar but shorter spinelets, placed close behind and forming a line slightly oblique to the median line of breadth of the plate. The second spine is about two thirds the length of the marginal spine, and the third is much less and more compressed. This triplet of spines is confined to the marginal edge of the plate, and no other spines are present, except on one or two of the innermost plates, the rest of the plate being covered with small uniform squamules; and these, though short, are more or less spatuliform and with rounded tips. Ventral plates only two or three present, bearing small uniform papilliform spinelets.

Ambulacral spines short, normally forming two series; but on some plates the outer series is somewhat irregular, and may simulate the appearance of three series. The inner or furrow-series consists of three spines, of which the middle one is longest, straight, cylindrical, and tapering; whilst the two lateral ones are short, delicate, compressed in the direction of the axis of the ray, slightly expanding towards the tip, and truncately rounded. The outer series are three in number, equal in size, broad, robust, flatly compressed in the direction of the axis of the ray, widely flaring towards the extremity and truncate. The middle spinelet is on some plates placed external to the two lateral ones, and sometimes, in consequence, appears like a solitary spinelet of a third series. Sometimes also the aboral lateral spinelet may be slightly in advance. On a few of the innermost plates one or two supplementary spinelets may be present.

Mouth-plates large and prominent, with a single line of short robust papilliform spinelets upon the surface of the keel along either side of the median suture; these are about 10 or 11 in number, and decrease in size ad- and aborally. Of the mouth-spines proper situated on the free margin of the plates, the three innermost on either side of the suture-line are long, robust, cylindrical, obtusely rounded, and form, together with the corresponding spines of the companion plate, the comb which stretches horizontally over the mouth-aperture. On the remaining portion of the free margin are 3 or 4 small, equal-sized, cylindrical spines. The first adambulacral plate next to the mouth-plate is narrow, with a biserial armature, consisting of about 8 small, compressed, slightly flaring, and truncate spines in each row.

The paxillar area is compact and uniform, rather more than three times the breadth of the supero-marginal plates at the middle of the ray. The paxillæ are longer on the disk and along the median dorsal line than at the sides of the rays, where they are arranged in regular transverse rows, about 5 in each. The larger paxillæ have a circlet of 10–12 short spinelets surrounding a rather large tabulum, on which 1–3 low granules are placed; and the smaller ones have about 8, with one central. The paxillæ are smaller and very compact in the centre of the disk, and a prominent conical peak is present.

The madreporiform body is transversely oval in form, and not more than its own breadth distant from the marginal plates.

The terminal plate is large and broad, very deeply channelled anteriorly, and with 2 or 3 short robust spinelets, which curve slightly over the furrow.

Colour, in alcohol, very light ochre-brown, almost verging towards grey.

Station 75. Lat. 38° 37′ N., long. 28° 30′ W. Depth 450 fms.; sand.

ASTROPECTEN PONTOPORÆUS, n. sp.

Rays five. $R=3{\cdot}5\,r$ app.; $R=53$ millim., $r=15$ millim. Rays rather broad throughout, and only slightly tapering until near the extremity, which, although pointed, is rather obtuse. Breadth of a ray at the base 16·5 millim. Interbrachial angles subacute, or with a faint tendency to rounding.

Supero-marginal plates 27 or 28 in number from the interbrachial angle to the tip, broader than long; height about equal to breadth at mid arm, but greater in the inner portion of the ray. The plates are well rounded and tumid, which gives them a crested or subtubercular appearance and clearly defines the separate plates. The plates are covered with small papilliform granules, which decrease in size towards the margins; and each plate normally bears an elongate granule or aborted spinelet, situated rather low down on the rounding between the dorsal and lateral surfaces of the plate; but not unfrequently two or three may be present, and these stand in transverse line along the median line of breadth.

Infero-marginal plates broad, rather sharply rounded on to the actinal surface, and do not protrude beyond the level of the superior series. Marginal spines 4 or 5 in an oblique line, only slightly inclined to the axis of the ray, passing from the adoral to the aboral side of the plate. The spines are short, cylindrical, tapering, and pointed; the third or fourth from the adoral end of the line is the longest, although there is no great disparity in the length of any of them excepting the first, which is very small. Two or three irregular rows, with the spinelets in each shorter than those in the preceding row, stand behind the marginal series, and form a gradual transition into the spiniform squamulation of the plate. Consequent on this arrangement the marginal spines have a short, compact, and almost tufted appearance; whilst the series form a thick and closely crowded fringe along the ray. The squamules of the infero-marginal plates are rather long, flat, and rounded or obtusely pointed at the extremity, and although numerous they are not very closely placed. Three or four more prominent squamules, simulating spinelets, form a line along the aboral margin of the plate, and occasionally similar ones may be found here and there on other parts of the plate. Ventral plates not more than 6–8 present, carrying very small, short, and equal-sized papilliform spinelets, which appear to form a kind of pedicellaria.

Ambulacral spines short, and forming two series. The inner series, consisting of three spines, short, cylindrical, slightly taper and obtuse, the middle one being more robust, compressed laterally, geniculated and prominent in the furrow. The outer series, near the middle of the ray, has three spines equal to, or rather longer than, the inner series, more robust, slightly compressed, and obtusely rounded at the tips, running obliquely across the plate, the adoral spinelet often being in the position of a third series. On the inner portion of the ray one or two supplementary spinelets may be present, external to the oblique line of three spines above mentioned.

Mouth-plates elongate, and form a long prominent narrow keel along the line of suture. Upon the keel there is a single line of spinelets on each plate, rather long, robust, compressed, and subpapilliform; these are 7–9 in number, and diminish in size aborally. On the outer free margin of the plate there are about 8 spinelets—the three innermost, which with the corresponding spinelets of the companion mouth-plate form the comb of spines projecting horizontally over the mouth, are longer than the rest, and are slightly curved inward at their extremities in the direction of the horizontal plane of the mouth-area. The remaining spinelets are much smaller and equal-sized, and their series do not reach beyond a line drawn at right angles through the middle of the median suture-line.

The armature of the first adambulacral plate beyond the mouth-plates consists of 15 or more pairs of small equal papilliform spinelets, ranged in two parallel lines and apposed to one another, which form a remarkably elegant organ probably of pedicellarian functions. On the outer portion of the second adambulacral plate there is a partial repetition of this arrangement.

The paxillar area is wide and extensive, with numerous rather small compact paxillæ. The spinelets of which these are composed are short and uniform. The larger paxillæ have a circlet of 12–14 spinelets surrounding 7 or 8 on the centre of the tabulum; and the smaller paxillæ present about half those numbers. Along the sides of the rays the paxillæ are arranged in regular transverse lines about 5 or 6 in each. The paxillæ diminish greatly in size in the neighbourhood of the centre of the disk and towards the ends of the rays.

The madreporiform body is small but tubercular, and is situated nearer the margin than midway to the centre.

The terminal plate is moderately large and broad, and is deeply grooved at the extremity.

Colour, in alcohol, yellowish white.

Station. Simon's Bay, Cape of Good Hope. Shallow water; 5–20 fms.

Astropecten zebra, n. sp.

Rays five. $R=3{\cdot}7\,r$; $R=34$ millim., $r=9$ millim. Rays rather narrow, and although tapering gradually from the base to the extremity, the tip is comparatively obtuse. Breadth of a ray at the base about 9 millim. Interbrachial angles distinctly rounded.

Supero-marginal plates 25 in number from the interbrachial angle to the extremity, higher than broad, and having the appearance of forming a rounded sloping bevel to the ray, especially in the arm-angle. The plates are uniformly covered with papilliform granules, and bear no spines or tubercles whatever, excepting the four innermost plates on either side of the median interbrachial line. These four or five plates are armed with a short, conical, and slightly compressed spinelet, the innermost being longest and the others decreasing in size as they proceed outward.

Infero-marginal plates much broader than high, and do not extend beyond the superior series, although in large specimens there is a tendency to appear to do so in consequence of the presence of a slight prominence on the plate on which the marginal spine is articulated. One marginal spine of moderate length, taper throughout and sharply pointed, cylindrical, very slightly flattened, accompanied by a second spine, about two thirds the length of the marginal spine, placed immediately behind and close to the aboral side of the plate. Two or three small compressed spinelets are situated in line on the aboral side of the plate, that near the inner extremity adjacent to the adambulacral plates often slightly largest. No other spines are present on the inferomarginal plates, which are covered with moderately well-spaced squamules.

Ambulacral spines forming three series on the inner part of the ray, but become reduced to two on the outer portion. The inner series consists of three spinelets, which are rather short, the middle one delicate and clavate at the extremity, and two lateral companions rather shorter, flat and obtuse. The second series consists of two or three spinelets shorter than the inner series and more or less flattened and truncate. When a third spinelet is present it is very frequently placed somewhat behind the other two, opposite their interspace; and might almost be counted with the third series, which latter may consist of only two or three small cilia-like spines or of four flat modified spines forming a well-developed pedicellaria. These organs are irregular in their occurrence and are only present on the inner half of the ray; on the outer part of the ray the third series of ambulacral spines is apparently wanting altogether. The pedicellariæ are large and conspicuous, and four or five are present along each side of a furrow, usually on alternate plates; all are uniform and with four valves, regularly apposed two and two, the spinelets which form the valves being more or less flattened and arched, and terminate in an abruptly pointed or lanceolate extremity. Ventral plates very few; the two immediately behind the mouth-plates each bear a large pedicellaria similar to those just mentioned.

Mouth-plates elongate and narrow, with a single line of comparatively long and robust spinelets along their superficies, cylindrical or slightly compressed and obtuse; all nearly uniform in size excepting the innermost one or two, which are somewhat larger than the others.

Paxillæ of the dorsal area large, having 1–4, or even more, central spiniform granules on the tabulum, surrounded by 8–12 short spinelets in a circle on the periphery. A slight prominence is present in the centre of the disk of some examples, but scarcely sufficient to produce a conical peak. In one specimen a slight invagination occurs in the centre of the prominence.

Colour, in alcohol —the paxillar area is of very light brown or chocolate-colour, and is mottled with spots and lines of a darker tint of the same. These marks fall in a line parallel with, and midway between, the marginal plates and the median dorsal line. On the inner third of the ray the line or band of colour is generally continuous and meets the corresponding band of the adjacent ray on the disk, forming a V-shaped mark, thickened in the angle. On the outer part of the ray the markings are discontinuous, forming spots, and these frequently extend up to and over the marginal plates. The actinal surface and sucker-feet are yellowish white.

Station 186. Lat. 10° 30′ S., long. 142° 18′ E. Depth 8 fms.; coral-sand.

ASTROPECTEN ZEBRA, var. ROSEA.

The examples of *A. zebra* from Station 186 are very constant in their characters. The specimens from Station 187 (three in number) present some variation. In colour they are a rosy brown, approaching that of madder-brown, and the markings are dark brown. The actinal surface is a delicate rosy pink, and the sucker-feet are rich scarlet. The rays are slightly broader and taper rather more rapidly at the tip. Only the two or three innermost supero-marginal plates bear spines, which are smaller and almost invisible excepting the innermost. The small spinelets on the aboral margin of the infero-marginal plates do not form the continuous line noted in the specimens from Station 186, but are wanting in the median portion, thus leaving the spinelet near the adambulacral plates isolated, and the spinelet near the marginal spines is relatively larger and might almost be counted along with the marginals.

Station 187. Lat. 10° 36′ S., long. 141° 55′ E. Depth 6 fms.; coral-sand.

ASTROPECTEN VELITARIS, *von Martens.*

Station. Amboina. Depth 100 fms.; 15–25 fms.

ASTROPECTEN GRANULATUS, *Müller & Troschel.*

Station 188. Lat. 9° 59′ S., long. 139° 42′ E. Depth 28 fms.; mud.

ASTROPECTEN MONACANTHUS, n. sp.

Rays five. $R > 3{\cdot}5\,r$; $R = 26$ millim., $r = 7$ millim. (another specimen, $R = 22$ millim., $r = 6$ millim.). Disk moderately large; rays rather long and narrow, tapering rather rapidly on the outer portion to a pointed extremity. Interbrachial angles rounded. Breadth of a ray at the base 6·25 millim.

Supero-marginal plates small, about 23 in number from the interbrachial angle to the tip, higher than broad, not tumid, forming an even and well-rounded margin to the ray; the extension on the dorsal surface small, consequent on the narrowness of the plates. The surface of the plates is covered with large, flat-topped, well-spaced granules, which diminish a little in size at the margins; and the suture or furrow between neighbouring plates is almost hidden. The usual fine cilia, if present, are entirely concealed. No spinelets or tubercles of any kind are borne on the supero-marginal plates.

Infero-marginal plates much broader than high, do not extend beyond the superior series, and have a sharp subangular rounding on to the actinal surface. Each plate bears a single marginal spine, and no other spines are present, the whole surface of the plate being covered with moderately well-spaced, small, flat, subacuminate squamules very little longer than broad. Two of the squamules immediately behind the marginal spines are longer than the rest and subspiniform. There is no tendency to spinulation on any other part of the plate. The marginal spines are short, delicate, subcylindrical, slightly compressed, tapering from the base to a very finely pointed extremity, and are very faintly curved: they are directed horizontally from the ray at right angles to the axis, and are wide apart; those in the middle of the ray are slightly longer than the others, which decrease in length towards the inner and outer portions of the ray; the longest spines are nearly equal to the length of three infero-marginal plates. Not more than two or three ventral plates are present, and these carry small papillose spinelets forming an incipient pedicellaria-like group.

Ambulacral spines short and rather robust, forming two distinct series, three in each. The inner series consists of three short, robust, obtusely-tipped spinelets, radiating apart and arching over the furrow, the middle spine longest. The outer series of three spines are much shorter than the inner series; the middle spinelet slightly longest and twice as robust as its companions, this spinelet having a short, flat, subspatulate form. The aboral spinelet is smallest and is placed in advance of the other two, its position almost suggesting that it ought to be reckoned as belonging to a middle series, an idea which is further strengthened by the presence in the innermost portion of the ray of a minute granule or rudimentary spinelet in a corresponding position on the adoral side of the plate. This arrangement causes the broader middle spinelet at first sight to appear as the aboral of two spines which form a true outer series, directed outward towards the margin of the ray.

Mouth-plates elongate and narrow, with a single row of 8–10 papilliform spinelets on their surface, which are very small outwardly, but increase in length as they approach the mouth, the innermost spine being longer than any of the others and directed horizontally. The two series of spinelets on the companion plates of a mouth-angle are generally apposed to one another. On the free margin of the mouth-plate there is a lineal series of short, rather robust spinelets directed horizontally, which increase in length as they approach the inner extremity of the plate, the innermost spinelet being very little shorter than the innermost spinelet of the superior series just mentioned, and, standing at the same level, forms together with it the horizontal fan of mouth-spines which proceed from each mouth-angle and cover the mouth. The adambulacral plate adjoining the mouth-plates is much broader and shorter than the others, and bears a lineal series of 8 or 9 short papilliform spinelets on either side, the two series being apposable.

The paxillar area is wide, measuring more than three times the width of the supero-marginal plates near the middle of a ray, and is very regular in composition. The paxillæ are large and well spaced, and have one large granule-like spinelet in the centre of the tabulum, and 7 to 10 very short clavate spinelets on the circumference radiating out widely, almost horizontally. Occasionally on the disk, paxillæ have 2–4 central granules; but the single, large-sized, low granule is very characteristic. On the sides of the rays the paxillæ are arranged in transverse lines about 3 or 4 in each; the median dorsal band scarcely defined. In the centre of the disk an anal peak is present, in the neighbourhood of which the paxillæ become very small and crowded. In some cases the centre of the cone is invaginated.

Madreporiform body entirely hidden by paxillæ.

Colour, in alcohol, ashy grey.

Station 203. Lat. 11° 7′ N., long. 123° 7′ E. Depth 12 to 20 fms.; mud.

ASTROPECTEN CINGULATUS, n. sp.

Rays five. $R > 3r$; $R = 28$ millim., $r = 9$ millim. Rays rather short and of moderate breadth, tapering gently with a slight curve to the extremity, which is not sharply pointed. Breadth of a ray at the base 10 millim. Interbrachial angles subacute and not rounded.

Supero-marginal plates 19 in number from the interbrachial line to the tip, all much broader than high, the breadth of those midway on the ray being greater than the adjacent paxillar area. The breadth of the supero-marginal plates increases towards the arm-angle, where the maximum is attained; the innermost plate of each ray, which is contiguous to the median interbrachial line, is triangular or wedge-form, the apex being directed outward; whilst the bases of the two adjacent triangles form a wide rounding to the inner contour-line of the marginal wall. The border formed on the dorsal surface by the marginal plates is very broad and conspicuous.

The length of the supero-marginal plates in the inner half of the ray is not more than one third of their breadth. The plates are slightly tumid along the median line of breadth, which produces a slight furrow between each; and the surface of the plate is covered with closely-placed uniform granules, which become finer along the margins. No spinelets, tubercles, or enlarged granules are present on the plates.

Infero-marginal plates broader than high, and extend very slightly beyond the superior series. Marginal spines two, standing side by side, equal in length, short, very delicate, cylindrical or faintly flattened, tapering to a sharply-pointed extremity and slightly bent. Behind these stand 2 or 3 very small delicate spinelets; and a row of 4 or 5 similar, though somewhat smaller, spinelets are placed on the aboral side of the plate. The surface of the plate is covered with small, flat, subcircular squamules, rather widely spaced, the margins being bordered with crowded short, delicate, ciliary spinelets, hidden in the divisional furrows. Only two or three ventral plates are present in the immediate interbrachial area; these carry usually one moderately long tapering spinelet surrounded by a marginal series of papilliform spinelets.

Ambulacral spines usually forming three series, although the third or outer series is often absent or indistinguishable from the ciliary spinelets of the ventro-marginal plates on the outer part of the ray. Inner series three in number, short, cylindrical or flattened transversely, slightly taper, the middle one a little longer than the companion spines and standing forward prominently in the furrow. The second series has usually two spines standing wide apart, opposite the two outer spines of the furrow-series; these spines are shorter than the inner trio, flattened in the plane of the axis of the ray, do not taper, and are roundly truncate at the extremity. Sometimes a third spinelet, similar in size and shape, is present between them. The outer series consists of three small papilliform spinelets, only slightly longer and more robust than the transitional or ciliary spinelets above mentioned.

Mouth-plates small and narrow, with a single line of rather long compressed spinelets, standing perpendicular to the superficies, excepting those near the inner extremity, which are directed horizontally over the mouth and are also larger and more robust; those at the outer extremity are directed outwards. Low down on the sides are a few small and irregular supplementary spines.

The paxillar area is very limited in consequence of the great breadth of the supero-marginal plates. The paxillæ are large upon the disk, but become smaller along the rays; the former have four or five rather large granules in the centre on the tabulum, surrounded by a dozen or more small short spinelets. Along the rays there are not more than two or three central granules, and these are arranged in line, the paxilla (tabulum) being more or less elongately oval in the direction of the axis of the ray. The paxillæ are closely placed. In the centre of the disk a small conical elevation is present, upon and in the neighbourhood of which the paxillæ are smaller.

The madreporiform body is about its own width distant from the marginal plates, and is almost hidden from view by the paxillæ.

Colour, in alcohol, almost pure white.

Station 122. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W. Depth 350, 120, 32, and 400 fms.; mud.

There is, unfortunately, no indication as to which of these dredgings the specimen came from.

Astropecten mesactus, n. sp.

Rays five. $R=3r$; $R=34$ millim., $r=11$ millim. Disk of moderate size and somewhat tumid; rays rather short and moderately broad at the base, tapering continuously to a finely pointed extremity. Breadth of a ray at the base about 11 millim. Interbrachial angle rounded.

Supero-marginal plates small, 21 in number from the interbrachial line to the tip, about as high as broad and slightly tumid; covered with papilliform granules, uniform in size and not very closely placed. Fine cilia in the furrows between successive plates. No spines or tubercles of any kind present on the supero-marginal plates.

Infero-marginal plates broader than high, the height being proportionally greater than usual in the genus; they do not extend beyond the level of the superior series, and form a gently rounded curve onto the actinal surface.

Marginal spines very small, short, straight, taper, and slightly compressed; four in number, placed close together in an oblique line passing from the adoral extremity of the marginal end to the aboral side of the plate, the third from the margin being the longest; the fourth spine is usually rather shorter than the third, but sometimes equal. These spinelets, though not closely appressed to the side of the ray, stand at an angle to the surface and are directed somewhat upward and outward. Behind the line of marginal spines is a line of small flattened spiniform squamules, larger than the general squamules of the plates; and on the inner part of the ray one or two similar spinelets may be found on the inner portion of the plate; these, however, are wanting on the outer part of the ray, and there are no spinelets on the aboral side of the plate. The surface of the plate is covered with short papillose spinelets rather than squamules, which become longer, more delicate, and very numerous in the furrows.

Ambulacral spines delicate and of moderate length, all cylindrical and only slightly taper, forming three regular series, with three spinelets in each. The inner series radiate well apart, and the middle spinelet is longest. The spinelets of the second series are all equal in length and slightly shorter than the inner series, and are frequently placed in a somewhat oblique line. The outer series are, perhaps, a trifle smaller than the second series, and do not always stand in a regular line; sometimes an additional spinelet is present and sometimes only two.

Ventral plates numerous, 20–30 being present in the interbrachial area, each bearing about 8–10 short delicate spinelets, rather widely spaced and radiating apart, which gives an appearance suggestive of paxillæ, and most of the plates, excepting the inner series, having a longer and more robust spinelet springing from the midst.

Mouth-plates rather short and small, covered with numerous closely-placed spinelets. A double line is present on the surface of the plate, those near the median line of the mouth-angle being largest, robust, compressed transversely, and with tips obtusely rounded, and increase in length towards the inner extremity of the plate. The innermost spines of the mouth-angle form a short horizontal comb of four parallel spines directed towards the centre of the mouth. The margins of the mouth-plates are fringed with a line of about 8 small ciliary spines, which decrease in size and robustness as they recede from the mouth.

The paxillar area is extensive over the disk, and contracts rapidly along the rays, terminating in a point, in conformity with the shape of the starfish. The paxillæ are moderately large, with a broad tabulum bearing in the centre one or occasionally two isolated granules, and surrounded by 8 to 12 short claviform spinelets around the margin which radiate outward slightly. There is a little diminution in the size of the paxillæ towards the centre of the disk, but no trace occurs of any anal prominence or peak whatever. The paxillæ are arranged in very short transverse rows at the sides of the rays, the irregular median space being wide. The paxillæ become very small towards the ends of the rays.

The madreporiform body is small, slightly convex, with fine striations, and is placed at about its own breadth distant from the marginal plates.

The ambulacral sucker-feet are pointed, and the extreme tip appears to be very slightly thickened.

The terminal (ocular) plate is elongate, and armed at the extremity with four or five short robust spinelets directed outwards.

Colour, in alcohol, brownish grey.

Station. Off Inaccessible Island, Tristan d'Acunha. Depth 90 fms.

A Revision of the Genus *Entomobrya*, Rond. (*Degeeria*, Nic.). By GEORGE BROOK, F.L.S.

[Read May 3, 1883.]

(PLATES X. & XI.)

M. BOURLET, in his paper before the Royal Society of Lille, in 1839, divided the *Poduræ* into five genera—two with scales and three without. Of the latter the genus *Isotoma* was characterized as follows :—" Corps non garni d'écailles, plus ou moins velu ; antennes courtes, de quatre articles, à peu près égaux " (p. 399). It may be here remarked that, from the above description, it is clear that Bourlet's name of *Isotoma* had reference to the segments of the antennæ being equal ; and this is borne out by the fact that Bourlet regarded the form and number of segments of the antennæ of the *Poduræ* as forming good generic characters. At the present time, however, unless one had access to Bourlet's papers, one would expect the name *Isotoma* to refer to the four subequal abdominal segments, as the form of the antennæ is no longer characteristic.

In 1842 Nicolet published a paper (Roy. Soc. Helv.), in which he divided the species included in Bourlet's *Isotoma* into two genera :—

Desoria, in which the first four abdominal segments are subequal.

Degeeria, in which the fourth abdominal segment is at least as long as the three preceding taken together.

The name *Desoria* has had to give way to the older one of *Isotoma*, and hitherto *Degeeria* has stood as a good genus. The name, however, is unfortunate, as it was already occupied for another genus of insects. Meigen in 1838 (Syst. Beschr. eur. Zweifl.) gave the name *Degeeria* to a parasitic genus of Diptera, which now forms a large and important genus of the order. Curiously enough, Nicolet's genus is the only one mentioned in Agassiz's 'Nomenclator.' If the two genera were very wide apart so that there could be no risk of confounding them, perhaps it would do no harm to retain Nicolet's name. Rondani (Dipterolog. Ital. Prodr. vol. iv.), seeing this difficulty, suggested the name *Entomobrya* instead of Nicolet's *Degeeria* ; and although the name is not a very suitable one, it will be better to accept this than confuse matters more by adding another to the list. Mr. Meade, in a note in the 'Entomologist's Monthly Mag.' vol. 18, also points this out; and Mr. McLachlan calls attention to the desirability of adopting Rondani's name. It is, however, particularly unfortunate that the name *Degeeria* has to be changed, as the genus is well established and has lent its name to a division of which it is the type.

The species of this genus are very widely distributed and very variable. Hitherto a considerable importance has been attached to the size, position, and colour of the various markings, so that it is only natural to expect a good many synonyms. In the first place, Lubbock (Linn. Soc. Trans. 1869) separated those species described by Nicolet as being clothed with scales, and founded a new genus for them under the name of *Sira*, on account of their linking together the genera *Entomobrya* and *Lepidocyrtus*. Of the species without scales Lubbock, in his Ray Soc. Monograph, has condensed the number to sixteen species, as follows:—

1. *E. nivalis*, L. (Nic. & Lubk.).
2. *E. annulata*, Fabr.
3. *E. albocincta*, Temp.
4. *E. lanuginosa*, Nic.
5. *E. Nicoletii*, Lubk.
6. *E. cincta*, Lubk.
7. *E. disjuncta*, Nic.
8. *E. corticalis*, Nic.
9. *E. muscorum*, Nic.
10. *E. fenestrarum*, Bourl.
11. *E. variegata*, Guér. & Per.
12. *E. membranea*, Nic. (Chili).
13. *E. incerta*, Nic. (Chili).
14. *E. decora*, Nic. (Chili).
15. *E. atra*, Nic. (Chili).
16. *E. fasciata*, Say.

In 1871, Tullberg (Fört. öfver Sv. Pod.) added two species to the list, viz.:—

E. arborea, Tullb. | *E. marginata*, Tullb.

and in 1873 Packard (Thys. of Essex Co., Mass.) added four more species to the American list, viz.:—

E. perpulchra, Pack.
E. griseo-olivata, Pack.
E. purpurascens, Pack.
E. decemfasciata, Pack. (*D. flavo-picta*, Pack., Study Ins. 3rd ed.; *D. flavocincta* of later editions).

In 1876 Reuter described a species which he queried *Degeeria*? *superba* (Cat. Pod. Fenniæ). Finally, Mr. H. N. Ridley described, in the Ent. Mo. Mag. 1881, another species under the name of *D. pulchella*. This makes now a total of twenty-four species hitherto described, which I now propose to reduce to eleven, for reasons which will be discussed under each species.

The first attempt at condensing the number of species of this order was made by Lubbock (Ray Society Monogr.) when he showed that *Orchesella cincta*, L., was of such a variable nature in its markings as to present almost every phase between a specimen without markings and one nearly black.

The object of the present paper is to show that in the genus *Entomobrya* also we have a common widely distributed species which, at different ages and under different conditions, presents a similar series of gradations from the light to the dark which have been proved to occur in *Orchesella cincta*, L. By the aid of photography I have been enabled to arrive at this conclusion with the more certainty, because I am always assured of the accurate mapping out of the markings, where drawing to be as accurate would be an extremely difficult task. Again, the camera has assisted me in the identification of certain markings which, when seen under the microscope and by gas-light, did not appear at all.

ENTOMOBRYA, *Rondani.*

1839. Isotoma, *Bourl.* (in partem).
1842. Degeeria, *Nic.* (in partem).

Mesonotum not prominent; fourth abdominal segment at least as long as the three preceding taken together. Eyes eight in each group. Antennæ shorter than the body, consisting of four segments and a minute basal ring; the three terminal ones subequal. Feet biunguiculate, each claw with a tenent hair. Upper claw usually with two teeth—one, well marked, about the middle of the inner margin, and the other smaller or sometimes absent. There is sometimes a small tooth on the outer margin. The number of the teeth seems to vary considerably in the same species, so that this character is of no specific value. Saltatory appendage long.

Body covered with long hairs which are clubbed on the anterior part of the body, and long and geniculate on the posterior part. Besides these there is a thick downy covering of fine short hair all over the body.

1. ENTOMOBRYA NIVALIS, *L.*

1740. "Små grå insekter," &c., *De Geer, Vet.-Akad. Hand.* vol. i. p. 276.
1758. Podura nivalis, *L. Syst. Nat.* ed. x. t. i. p. 609.
1835. P. nigromaculata, *Temp. Thy. Hibern.* p. 94.
1838. P. minuta, *Burm. Handb. d. Ent.* B. ii. p. 449.
P. nivalis, *Burm. ibid.* p. 450.
1858. Degeeria pi, *Herklots, Tijds. v. Entom.* vol. i. p. 94.
1862. D. nigromaculata, *Lubk. Notes Thy.* pt. ii. p. 593.

1871. D. nivalis, *Tull. Œfver Sv. Pod.* p. 148.
1873. D. annulata, (*Fabr. of*) *Lubk. Ray Soc. Monogr.* p. 109.

Ground-colour usually greenish yellow, with the markings very distinct. Antennæ a little more than half the length of the body; terminal three segments subequal. Second thoracic ring large, with a faint basal band; third thoracic half the length of the second, marked as in the preceding but a little darker. First abdominal ring very narrow, almost without band; second and third abdominals increasing in width, with broad bands somewhat triangular at the extremities; fourth abdominal a little longer than the four preceding segments taken together, with two triangular bands with their apices reaching the base of the segment, their bases never uniting, the whole segment tapering considerably towards the base; fifth and sixth abdominals with marginal bands.

This species is not very variable; the markings on the fourth abdominal segment, by which this species can be recognized at a glance, are usually well defined and clear in outline; if any bands are absent, those on the thorax disappear first. I have not seen any specimen, however, without markings altogether on the first and second abdominal segments. Length $\frac{1}{10}$ inch.

Found throughout the year under logs of wood, &c. I have also found it on ling, grass, elder, furze, willow, birch, alder, pine, and lichen. In some specimens of this species there are four sheaths around the mucros, instead of two as is usually the case.

I agree with Tullberg that Nicolet and Lubbock have not correctly identified the *P. nivalis* of L. Linnæus always refers to the figure of De Geer for this species, and there can be no doubt as to its identity on a comparison of the figures. Nicolet's species is nevertheless a good one; and here in England is much the commonest of the genus. Since the time of Nicolet his species *nivalis* has been regarded as identical with that of Linnæus, with, as far as I am aware, no exception until the publication of Tullberg's 'Sveriges Podurider.' It is true that Herklots (Tijds. v. Entom. 1858) assured himself that two distinct species were confounded under the one name. He suggested that the species described by De Geer as "*Podura campestris cinerea*" (Act. Ups. 1840) and as "*Podura arborea grisea*" (Mém. sur les Insectes, vii.) should be known as *Degeeria pi.* I think, however, that when Linnæus and De Geer agreed that the former's *nivalis* was the same species as that of the latter, it is Nicolet's name which should be changed. I have therefore added *D. pi*, Herkl., to the list of synonyms of this species, and accepted Tullberg's name *multifasciata* for that of Nicolet.

Hab. Britain, Finland, Sweden, France, and Italy.

2. ENTOMOBRYA INTERMEDIA, n. sp.

Antennæ very long and slender as compared with the other species of this genus; yellow at the base and gradually shading off to violet. Some of the darker specimens have a black ring at the apex of the first segment. Head with an anterior black band extending across the base of the antennæ, and continued along the lateral margins; an anchor-shaped patch in the centre. Second thoracic segment about a third longer than the third segment. First abdominal segment about half the length of the second, with only a faint line on the posterior margin and two or three light lateral patches; second abdominal with dark lateral markings, and four small patches in the centre of the dorsal aspect; third abdominal segment with dark lateral markings, and a triangular patch pointing downwards from the centre of the anterior margin; fourth abdominal segment rather longer than the three abdominal and the third thoracic segments taken together, only slightly tapering to the base; there is a central large triangular patch uniting the two very bold lateral longitudinal bands; there is also a dark spot in the centre of the posterior margin; fifth and sixth abdominal segments small, with a dark lateral band. General body-colour yellow, with brown to almost black markings. Body slightly widening to the third abdominal segment, and rather wider at the posterior end of the fourth than at the mesothorax. Spring reaching beyond the ventral tube; dentes and manubrium subequal. Upper claw with a distinct tooth about the centre of the inner margin, and a fainter one halfway between that and the tip. Lower claw lanceolate, half the length of the other. Length $\frac{1}{9}$–$\frac{1}{10}$ inch, width $\frac{1}{32}$–$\frac{1}{50}$ inch. Length of antennæ $\frac{1}{13}$–$\frac{1}{16}$ inch.

The young of this species is interesting as showing the development of the markings of the adult. The terminal segment of the antennæ is much longer than any of the others; but this is usually the case with young specimens. The markings are not yet complete; there is no triangular patch on the central posterior margin of the third abdominal segment, but the central spot on the base of the fourth and two lateral ones on the fifth are already present. There is as yet no triangular patch connecting the two lateral bands on the fourth abdominal segment, though the photograph shows indications of one. This is owing no doubt to the actinic effect of the darker yellow of the skin prior to the formation of distinct markings. The fourth abdominal segment is longer than the three preceding and the metathorax taken together. The upper claw appears untoothed; the lower one nearly as long as the upper in the third pair of legs, not so long in the others. Tenent hair not much dilated.

This species comes nearest to *E. nivalis*, both in shape and in markings. In shape it differs in having the antennæ longer and not so dilated; the fourth abdominal segment longer and not so tapering, so that altogether the animal is less fusiform than in *E. nivalis*. In markings the chief differences are the triangular patch uniting the two lateral bands on the fourth abdominal segment and the central basal spot on the same, both of which seem very constant in this species, and which I have never observed in any other *Entomobrya*.

This species has been sent to me by Mr. J. Sinel, of Jersey, who has gathered it several times from May to August 1882 on the surface of stagnant pools. Hitherto I am not aware of its being found in England. I have, however, a mounted specimen sent me by Miss Garrod, and labelled "Kahlenberg Woods, near Vienna, August 1882," which is probably a pale variety of this species. The shape, particularly in the antennæ, is that of *E. intermedia*; but the markings are more like Lubbock's *E. Nicoletii*, with these additions, that there is a faint lateral band running the length of the thorax and first three abdominal segments, a pale streak on each side of the fourth abdominal segment and a central dark line at the base; there is a prominent central black band on the fifth abdominal segment. I have also had the opportunity of examining another specimen, which convinces me that this is at any rate a distinct variety, and I have named it provisionally var. *elongata*.

Hab. Channel Islands; Austria (var. *elongata*).

3. Entomobrya multifasciata, *Tullb.*

1821. Podura fasciata, *Say* ? (*Journ. Acad. Phil.* vol. ii. p. 12).
1838. P. variegata, *Guér. & Per. Gén. des Ins.*
1840. P. simplex, *Koch, Fauna Ratisbonensis, Herrich-Schäffer's*, iii. p. 354.
P. striata, *Koch, ibid.* p. 354.
1841. Degeeria nivalis, *Nic. Mém. Soc. Helv.* p. 70.

1841. D. lanuginosa, *Nic. ibid.* p. 74.
D. disjuncta, *Nic. ibid.* p. 71.
D. corticalis, *Nic. ibid.* p. 72.
1862. D. nivalis, *Lubk. Notes on Thys.* pt. ii. p. 594.
1867. D. Nicoletii, *Lubk. Linn. Soc. Trans.* p. 299.
1871. D. muscorum, (*Nic. of*) *Tullb. Fört. öfver Sv. Pod.* p. 148.
D. multifasciata, *Tullb. ibid.* p. 148.
D. arborea, *Tullb. ibid.* p. 148.
D. marginata, *Tullb. ibid.* p. 148.
1873. D. decemfasciata, *Pack.* ? *Thys. Essex Co., Mass.* p. 40.
1881. D. pulchella, *Ridley, Ent. Mo. Mag.* vol. xvii. p. 270.

Type.—Antennæ about half the length of the body; the three terminal segments usually subequal, but the second may be either a little longer or a little shorter than the other two. Colour yellow, shading off to violet in the lighter specimens, to brown in the darker ones; there is sometimes a brown ring at the tip of the first segment.

Head yellow, with a broad dark band around the margin as seen from above crossing the eye-patches. The anchor-shaped band on the crown of the head is usually well defined.

Mesothorax slightly longer than metathorax, with a dark band on its anterior margin which runs along the epimera as far as the fourth abdominal segment; there is also a strong central basal band not reaching the margin; there is a similar basal band on the metathorax.

The first three abdominal segments increasing in length, with similar dark basal bands on each; that on the first shows a little thickening at the extremities; those on the second and third have this thickening increased to a triangular patch. Fourth abdominal segment not so long as the first three and the metathorax taken together, fusiform, with two interrupted bands—one across the centre and one across the basal portion of the segment, sometimes the two bands unite by triangular patches on each side of the median line: this segment is narrower at the base than the mesothorax. Fifth and sixth abdominal segments small, with strong basal bands.

Spring not passing the ventral tube. Claws strong; the upper one with a tooth about the centre of the inner margin, but there is often another smaller one, and sometimes a very small one on the outer margin. Lower claw lanceolate. Lateral plates lanceolate and a little curved; sometimes the tip of one of these plates is in such a position as to be easily mistaken for a strong tooth on the upper claw. Length $\frac{1}{15}$ inch, width $\frac{1}{50}$–$\frac{1}{60}$ inch.

ENTOMOBRYA MULTIFASCIATA, var. PULCHELLA, *Ridley*.

The basal two segments of the antennæ yellow ringed with brown, the terminal two dirty violet. Head dark anteriorly, but behind the anchor-band there are no markings. Mesothorax with a broad dark band anteriorly, proceeding backwards along the epimera as in the type. No basal band on this segment. Metathorax dark brown, excepting two or three small spots of yellow on each side. First abdominal segment without coloured band. Second abdominal with a strong dark band along the basal margin, and the same colour occupying nearly the whole of the segment. Third as second, but perhaps a little more yellow showing through towards the anterior margin. Fourth abdominal segment has the basal two thirds occupied with the dark brown colour, excepting an irregular triangular pale patch just above the basal line, and another at each side; the basal margin itself is very dark. Fifth and sixth abdominal segments almost entirely dark brown. Legs pale, with dark patches on the femora. Spring pale.

This variety was found by Mr. H. N. Ridley under the dead bark of an elm at Cumnor, Berkshire, in March 1879, and was described by him as a new species in the 'Entomologist's Monthly Magazine' for May 1881. Mr. Ridley has kindly forwarded me a specimen of this species, which I have examined carefully and compared with many other specimens. In some respects the specimen I have differs from Mr. Ridley's description, and, again, from a sketch which he also sent me. I cannot say that I have a specimen exactly like the one supplied, but then it would be difficult to find two insects exactly alike. The chief characteristics of this variety are the absence of markings on the basal part of the mesothorax, and also on the first abdominal segment, coupled with the greater proportion of colour on other parts of the body. I have specimens without a basal band on the mesothorax and also without any markings on the first abdominal segment; in fact, I find that if you compare a series of specimens these two bands are the first to disappear. Again, I have specimens in which nearly all the other segments are marked as in *pulchella*; so that I think I am justified in regarding this as a dark variety of *multifasciata*, more particularly as I have observed almost every gradation of change from this to var. *lanuginosa*, in which there are no markings at all.

Entomobrya multifasciata, var. Nicoletii, *Lubk.*

Terminal two segments of the antennæ violet. There is a dot between the antennæ, two spots of colour on each side of the centre of the basal margin of the fourth abdominal segment, and a dark basal line on the fifth. There are no markings elsewhere, and the general body-colour is yellow. There are, however, no strangulations in the antennæ and between the manubrium and dentes as figured by Lubbock; but I have not observed these in any species of *Entomobrya*. Tullberg included this as a variety of his *muscorum*; but I regard *muscorum*, Tullb., and *multifasciata*, Tullb., as varieties of the same species, and the variety *muscorum* comes intermediate between the type and Lubbock's *Nicoletii*; but as I do not think it a constant form, I have not ranked it here as a variety. I am now speaking of Tullberg's *muscorum*; the variety described under that name by Nicolet is much more likely to be a young *Orchesella*. I have a specimen of *O. cincta* in my collection almost identical with Nicolet's figure.

I have one gathering of over 100 specimens, all collected from a stunted elm in St. Clement's Bay, Jersey, in which there is not only the typical *multifasciata*, *Nicoletii*, and *lanuginosa*, but many intermediate forms, so that I think there is little doubt of these being varieties of the same species. I have photographed a good many specimens, some of which are used to illustrate this paper, descriptions of which will be found at the end.

Entomobrya multifasciata, var. lanuginosa, *Nic.*

This variety has no markings, and is usually rather more hairy than the other varieties. The first mark that appears is one between the antennæ; then those at the base of the fourth and fifth abdominal segments, as in typical *Nicoletii*. After this the markings on the fourth abdominal segment spread a little, the line along the epimera begins to show itself; next a double row of dots along the segments from the metathorax to the third abdominal segment; and a third development of these brings us to the typical *multifasciata*. In fact, unless all these forms are regarded as one species, one might raise almost every half dozen specimens to the rank of a species. Doubtless the nature of the environment has something to do with the development of colour in this species; for instance, I have usually found specimens from the low herbage on sandhills to be pale yellow and almost all without markings, and those from the trunks of trees usually are of the darker varieties. I cannot say, however, how far this hold good. Doubtless age has also something to do with it, as young specimens have usually fewer markings than old ones. On the other hand, I have quite young specimens with indications of all the typical markings of *multifasciata*, and others of the *lanuginosa* and *Nicoletii* varieties that are full-grown.

Hab. (*E. multifasciata* and vars.). Britain, including Channel Islands, Siberia, Finland, Sweden, Switzerland, France, Italy, and North America.

4. ENTOMOBRYA ALBOCINCTA, *Temp.*

1835. Podura albocincta, *Temp. Trans. Ent. Soc.* vol. i. p. 95.
1862. Degeeria cincta, *Lubk. Linn. Soc. Trans.* p. 594.

This species is very much of the form of *E. multifasciata*, though rather smaller. The antennæ are about half the length of the body; the first segment is dark yellow, with a black ring at the apex; the second is a dark dirty violet in the apical half, and the other two are the same colour. The head is brown anteriorly, shading off to yellow. The mesothorax has a dark band in front; the ground-colour is yellow, which gets very pale towards the posterior extremity. The metathorax and the first three abdominal segments are black; the fourth has the basal two thirds black and the upper third dark yellow. The fifth and sixth abdominal segments are yellow. Length $\frac{1}{15}$ inch.

I regard Templeton's species as a young form of that described later by Lubbock, because some specimens I found under tiles as described by Templeton, and which answered fairly to his description, assumed when kept in confinement the *cincta* form of Lubbock. Templeton's name should therefore be the one used to designate this species.

Hab. Britain (originally described from Ireland) and Channel Islands; but hitherto not recorded elsewhere, although very common in England.

5. ENTOMOBRYA ? SUPERBA, *Reuter.*

1876. Degeeria ? superba, *Reuter, Med. Soc. pro Fauna et Flora Fennica*, i. p. 85.

Reuter's description is as follows :—

" Flava, capite, ore excepto, mesonoto disco dimidio basali lateribusque fere totis, metanoto segmentisque que abdominis secundo et tertio fascia basali lata et in lateribus dilatata, nec non segmento abdominis quarto nigris, hoc quarto parte basali margineque apicali flavis, segmento quinto fascia transversali, furcula anali basi lineis duabus longitudinalibus, femoribus posticis annulis duabus, altera media, altera subapicali, antennisque corpori fere longitudine æqualibus annulo subapicali articuli secundi annulisque basali et apicali articulorum tertii et quarti nigris, articulo quarto duobus penultimis longitudine subæquali, obscurius rufescenti-testaceo. Long. $2\frac{1}{3}$–$2\frac{1}{2}$ mm.—Species pulcherrima et distinctissima verisimiliter ad gen. *Degeeria* referenda. Forsitan generis *Siræ* species, sed in hoc casu squamis saltim in speciminibus descriptis detritis." *Hab.* Finland.

I am unable to express any opinion on this species.

The following four species have been described by Nicolet from Chili:—

6. Entomobrya membranea, *Nic.*

1849. Degeeria membranea, *Nic., Gay's Hist. Chile.*

"*D.* elongata, pallida; antennis crassis, longitudine corporis; abdominis segmento quarto duplo longiore primis tribus conjunctim. Affinissima præcedenti." He adds:—"Body not very hairy, entirely of a dirty white, yellowish and shining, like old parchment. Long. 1 line." *Hab.* Chili.

This species is probably a *Sira*, as the "preceding species" to which he refers (*D. crassicornis*) is a scaled species.

7. Entomobrya incerta, *Nic.*

1849. Degeeria incerta, *Nic., Gay's Hist. Chile.*

"*D.* elongata, villosa, fusco nigroque variegata; pedibus furcaque flavescente nigro maculatis." He adds:—"Body of a dark yellowish fuscous, irregularly spotted with black; legs and spring yellow, with several black spots. Antennæ yellow, ringed with black at the articulations. Long. 2 lines."

This species differs from the others of the genus by having the fifth and sixth segments about equal in length, and the spring short, approaching that of *Isotoma*. *Hab.* Chili.

8. Entomobrya decora, *Nic.*

1849. Degeeria decora, *Nic., Gay's Hist. Chile.*

"*D.* oblonga, depressa, flava, corpore nigro maculato, antennis primis articulis luteis, ultimo nigro; pedibus furcaque flavescentibus." The anterior margin of the head and the eyes are black; the first segment of the thorax is of a paler yellow than the rest of the body, margined with black. The abdomen has a median longitudinal band composed of four transverse, quadrate, black spots united with each other; along the sides another row of irregular spots placed obliquely. Length $\frac{1}{2}$–1 line. *Hab.* Chili.

9. ENTOMOBRYA ATRA, *Nic.*

1849. Degeeria atra, *Nic., Gay's Hist. Chile.*

" *D.* oblonga, depressa, nigra; pedibus furcaque pallide testaceis." Shining and uniform black, pale beneath; antennæ fuscous. Long. $\frac{1}{2}$ line. *Hab.* Chili.

The following three species have been described by Packard from the United States:—

10. ENTOMOBRYA PERPULCHRA, *Pack.*

1873. Degeeria perpulchra, *Pack. Thys. Essex Co., Mass.* p. 38.

" An exceedingly beautiful species, smaller than usual. Body rather ovate in form; third abdominal segment rather long. Antennæ rather short and thick and more hairy than usual; third joint rather shorter than the fourth, the latter joint more ovate and pointed than usual. Clavate hairs on the head and thorax; end of the body and elater quite hairy. Antennæ purplish, concolorous with the head and thorax. A broad conspicuous band runs along the side of the head, including the eyes; a similar line on front and side of thorax. A much broader, conspicuous, black dorsal band on third thoracic (the first or prothoracic not seen from above) segment. The abdomen and basal half of the elater honey-yellow; end of the elater whitish; lower edge of second joint rather coarsely serrulate, the joint dilated where the teeth end, beyond simple, flexed as usual; this portion not so long and slender as in many species; the terminal hairs do not reach to the end of the third joint; this latter joint much as usual, with a stout long terminal tooth and a slender long inner tooth. Legs whitish. Claws very slender, smaller one scarcely more than half as long as the larger, a single large tenent hair unusually swollen at the extremity. Length ·04–·05 in." *Hab.* North America.

11. ENTOMOBRYA GRISEO-OLIVATA, *Pack.*

1873. Degeeria griseo-olivata, *Pack. Thys. Essex Co., Mass.* p. 39.

" Pale olive-green, with dark purplish leaden antennæ, the legs much paler, purplish; elater whitish. Body above hairy, especially on the thoracic segments. Eye-patches black, connected by a slender black line in front. A blackish line (sometimes wanting) along the lower edge of the segments and hinder edge of the last abdominal segment. Antennæ rather stout, moderately long. Posterior end of body with rather stout clavate hairs, with a few long bowed hairs scattered among them. Elater with several long hairs at the end, one longer and larger than the other and reaching a little beyond the end of the third joint; the second joint is serrulate along lower edge, it suddenly narrows a little below the end and is a little curved; third joint about three times as long as wide, ending in a large hook, with a much smaller supplementary tooth. Long ·05–·06 in."

Under bark of trees. *Hab.* North America.

12. Entomobrya purpurascens, *Pack.*

1873. Degeeria purpurascens, *Pack. Thys. Essex Co., Mass.* p. 39; *Guide to Study of Insects,* pl. 10. f. 4 & 5.

"Eyes black, with no connecting-lines. This is rather a large species, with unusually long slender antennæ; with the body, legs, and antennæ of a purplish lead-colour, the purplish tint especially noticeable on the two basal joints of the antennæ. Not very hairy; the hairs on the prothorax and head of quite uniform length, club-shaped, those on the posterior end of the body very slender, no bowed ones amongst them (though my specimens are somewhat rubbed). Legs slender, claws long and slender, larger claw with two acute prominent teeth along the inner edge. Elater with long dense hairs along upper side of second joint; serrulate, the teeth suddenly ending, leaving the end narrow, slender, naked, slightly bent, with a long hair projecting beyond the tip of third joint; this joint rather short, much curved on the outer side, ending in a rather slender hook, with an inner one of nearly the same size. 'Catch' large; basal joint longer than broad, with a stout bristle arising from middle of anterior edge and reaching nearly to tip of second joint, both front and hind edge with three or four notches; second joint very slender on the toothed portion, four-toothed, whole joint one half as long as first joint. Length ·08–·09 in. Under boards and bark of trees." *Hab.* North America.

This description is taken from the 'Thysanura of Essex County, Mass.'

Packard also describes another species, *D. decemfasciata,* in the above list. This species is figured in 'Study of Insects,' 3rd ed. pl. 10. f. 2, 3, under the name *D. flavopicta* (changed to *flavocincta* in the latest editions). I have considered it so near to our *multifasciata* that I have included both names as synonyms. Packard also remarks that his species is very variable.

DESCRIPTION OF THE PLATES.

PLATE X.

Fig. 1. Typical antennæ of *Entomobrya*, ×50.
2. Claw (side view), ×200.
3. Claw (semi-dorsal view), ×200, showing lateral plates.
4. Tenent hair, seen from above.
5. Left eye-patch, ×300.
6. Clubbed hair from thorax, ×100.
7. Spring, ×50.
8. *Mucro*, under view, } ×200. *a*, Setæ on the sides of the *dentes*.
9. The same, side view, }
10. The same, apex, ×800.
11. Seta from *mucro*, ×600.
12. *E. nivalis*, L., ×16.
13. *E. intermedia*, n. sp., ×16.
14. The same, ×16. This specimen has been flattened a little by the cover-glass pressing a little on it, so that the body looks wider and more fusiform than it really is.
15. *E. intermedia*, ×16. Young specimen. The central patch uniting the two lateral bands on the fourth abdominal segment only appears of a little darker yellow colour in the specimen, but this in photography takes dark. It evidently shows that the band is in process of formation.
16. *E. intermedia*, var. *elongata*, ×16.
17. *E. albocincta*, Temp., ×16.

PLATE XI.

Fig. 18. *Entomobrya multifasciata*, Tullb., var. *pulchella*, Rid., ×16.
19. *E. multifasciata*, Tullb. (dark form), ×16.
20. The same (type), ×16.
21. The same (pale form), × 16.
22. The same, approaching var. *Nicoletii*, Lubk., ×16. No central dorsal markings. A line in front of the head, and another along the epimera, besides the marks on the third and fourth abdominal segments.
23. The same, var. *Nicoletii* nearly, Lubk., ×16. The upper part of the bands on the fourth abdominal segment (*a*) only appears in the object itself as darker yellow than the surrounding colour, and thus, by photography, come out as bands. This is very interesting, as showing the transitional stage in which this specimen is. This is evidently a young form.
24. The same, var. *Nicoletii*, Lubk., ×16.
25. The same, var. *lanuginosa*, Nic., ×16. Although this specimen has no markings, the dark body-colour on the fifth and sixth abdominal segments (*a*) and the base of the fourth comes out by photography as darker bands, showing an approach to var. *Nicoletii*, Lubk.
26. The same, var. *lanuginosa*, Nic., ×16. This is a typical specimen.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part XVIII.

By the Rev. R. BOOG WATSON, B.A., F.R.S.E., F.L.S.

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[Read March 15, 1883.]

Order OPISTHOBRANCHIA, *Milne-Edwards.*

Family TORNATELLIDÆ, *Fleming.*

Genus ACTÆON, *de Montfort.*

1. *A.* (*Actæonina*) *edentulus,* n. sp.
2. *A.* (*A.*) *chariïs,* n. sp.
3. *A. turritus,* n. sp.
4. *A. austrinus,* n. sp.
5. *A. amabilis,* n. sp.
6. *A.* (*Buccinulus*) *cinereus,* n. sp.

1. ACTÆON (ACTÆONINA) EDENTULUS, n. sp.

St. 149 *c.* Jan. 19, 1874. Lat. 49° 32′ S., long. 70° E. Balfour Bay, Royal Sound, Kerguelen. 60 fms. Mud.

Shell.—Fragile, ovate, white, with a thin chestnut epidermis, a bluntish scalar spire, a largish mouth, inner lip untoothed. *Sculpture.* Longitudinals—there are very many close-set minute lines of growth, with here and there one much stronger than the rest which cuts in like a fault on the spirals, interrupting their continuity. Spirals—there are many regular, but not sharp-cut nor stippled furrows which corrugate even the interior surface of the shell: about 70 of these are on the body-, about 20 on the penultimate whorl. They are strongest toward the middle of the body-whorl, and somewhat faint toward the upper suture; the flat surface between them, which is about thrice their breadth, is more or less distinctly scored by a very faint furrow. *Colour* opaque white, covered with a thin glossy chestnut *epidermis*, which is a little darker below the suture and on the base. *Spire* rather high, roundedly and bluntly conical, scalar. *Apex* slightly eroded, but evidently blunt, large, and slightly inverted. *Whorls* $5\frac{1}{2}$, somewhat convex, of rather rapid but regular increase; the last is long and cylindrical, with a rounded produced base. *Suture* oblique, strong; axially impressed rather than channelled. *Mouth* long, transversely pear-shaped, narrowing very gradually above, open and rounded below. *Outer lip* a little patulous above, a good deal so on the base: it rises from the body-whorl at a right angle, but immediately bends downwards and runs forward to the base quite straight and parallel to the axis; across the base it is slightly emarginate. *Inner lip*: a thin narrow white glaze crosses the body and borders the pillar, which is narrow, concave, with a rounded, slightly twisted, and feebly marginated edge. There is no tooth. H. 1. B. 0·5. Penultimate whorl, height 0·2. Mouth, height 0·65, breadth 0·31.

This fine species is only represented by one somewhat broken specimen. In regard to the genus *Actæonina* of d'Orbigny, I may offer a few remarks. The name dates from 1850 ('Prodrome,' i. p. 353), and was intended for some fossil forms, regarding which any one desirous of further information may consult Morris and Lycett, "Mollusca from the Great Oolite," Palæont. Soc. vol. i. p. 102, v. pp. 11, 12, xviii. pp. 14, 15, Supplement, pp. 26–28, and 106, 107, pl. xxxi. f. 9, 13; Pictet, 'Paléontologie,' 2nd ed. iii. pp. 102–106, lx. pp. 13–22; Chenu, 'Manuel,' i. p. 225. I am not called on to discuss the forms which have been embraced in this genus; they seem to be a somewhat miscellaneous assemblage; but I feel quite sure the 'Challenger' shell may very well come in under the convenient definition of Pictet (*l. c. suprà*), "*Actéonina*—leur forme normale est celle d'Actéons sans dents."

Deshayes, in his 'Anim. s. Vertéb.' Paris, ii., substitutes for *Actæonina* the name *Orthostoma* as of earlier date. Agassiz, in his 'Index universalis' (Soleure edit.), p. 764, quotes for this name "Gray, Moll. 1840;" but the name *Orthostoma* belongs to Conrad (Geol. Rep. N. York, p. 115), 1838, and was proposed for a "Genus Nautileorum," which fact of itself would exclude it from rivalry with *Actæonina*, apart altogether from the fact that the name had been already proposed in 1831 by Ehrenberg for a genus of Vermes, and by Serville in 1834 for some of the Coleoptera.

2. ACTÆON (ACTÆONINA) CHARIÏS, n. sp.

St. 78. July 10, 1873. Lat. 37° 26′ N., long. 25° 13′ W. Off San Miguel, Açores. 1000 fms. *Globigerina*-ooze.

Shell.—Small, ovate, thin, translucent white, with flatly rounded whorls, a short subscalar very bluntly tipped spire, a largish roundish mouth, sinuated outer lip, and edentulous pillar. *Sculpture.* Longitudinals—there are numerous, unequal sinuous, hair-like, obsolete lines of growth. Spirals—the whole surface is scored with flattish rounded threads and shallow furrows of half their breadth between; these become feeble in the middle of the whorls; the furrows are not stippled. *Colour* translucent white and glossy. *Spire* conical, scarcely scalar. *Apex* extremely blunt, being suddenly truncated and flattened; the extreme tip is very slightly inverted. *Whorls* $4\frac{1}{2}$, constricted above, flatly rounded in the middle, and very faintly constricted below; the last is a very little tumid, with a rounded and slightly produced base. *Suture* strong, slightly oblique, impressed and slightly channelled. *Mouth* roundly pear-shaped, very bluntly pointed above. *Outer lip*: there is a strong shallowish and wide sinus above; below this the lip-edge (straight in its direction) is prominent, with a very slight emargination on the patulous and rounded base-line. *Inner lip*: an excessively thin and narrow glaze crosses the body, which is scarcely convex; the line of junction with the pillar and out to the point of the shell is roundly concave: the lip-edge on the pillar is narrow and sharp, and there is behind it a small furrow. H. 0·1. B. 0·05. Penultimate whorl, height 0·02. Mouth, height 0·05, breadth 0·03.

This species is very slightly like *A. exilis*, Jeffr., still more *A. bovetensis*, Seguenza, but is obviously different from both.

3. Actæon turritus, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Strongish, oblong, pale yellow, translucent, somewhat glossy, with a high conical coarsely tipped spire and rounded striated whorls. *Sculpture.* Longitudinals—there are many feeble lines of growth. Spirals—the surface of the shell is scored with narrow, shallow, irregular, unequal, distant furrows formed by hardly continuous stipplings which are round on the upper and oblong on the last whorl; between these furrows there often occurs a weaker one formed in the same way; on the base they are small and crowded; toward the upper suture they are strong, the first in particular is so. *Colour*: the shell itself is translucent white, but is covered with a very thin yellow membranaceous *epidermis*. *Spire* high, conical, and scalar. *Apex* very coarse and blunt, slightly immersed, but not inverted. *Whorls* 6, rounded above, cylindrical below; the last is short and slightly tumid. *Suture* very little oblique, strong and somewhat channelled. *Mouth* oval to pear-shaped. *Outer lip* leaves the body at a right angle; it is regularly arched throughout, patulous in front. *Inner lip*: a thin defined glaze crosses the body and runs direct down the pillar with a straight sharp edge, behind which is a minute chink; the tooth, which is close up to the body, is very slight and blunt. H. 0·31. B. 0·18. Penultimate whorl, height 0·08. Mouth, height 0·17, breadth 0·1.

This species is represented by only one specimen, of which the outer lip is somewhat broken. The spire is extremely high and scalar. In this respect and in the rounded form of the whorls it somewhat resembles *A.* (*Solidula*) *suturalis*, A. Ad.; but the apex is much blunter and the sculpture much finer than in that species.

4. Actæon austrinus, n. sp.

St. 162. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ E. Off East Moncœur Island, Bass Strait. 38 to 40 fms. Sand.

Shell.—Small, thin, ovate, strongly striated, with a high conical spire, blunt tip, and tumid body-whorl. *Sculpture.* Longitudinals—the lines of growth are very faint and somewhat markedly oblique. Spirals—the whole surface is scored with strong equal furrows which are about half the breadth of the interstices: these furrows are not stippled, but are delicately and regularly cut across on the lines of growth by fine threads: there are about 20 of these furrows on the body and about 9 on the penultimate whorl. *Colour* porcellaneous, with a glossy surface. *Spire* rather high, conical, subscalar. *Apex* rather large, blunt and flattened, with a very slight inversion of the extreme tip. *Whorls* nearly 5, very little convex; the last is rather large and somewhat tumid. *Suture* rather oblique, slight, scarcely impressed. *Mouth* oval, pointed above, a little oblique in its direction. *Outer lip* sharp and thin, with its edge crenulated by the sculptural spirals; in direction it is straight above, well curved on the base, where it is very slightly emarginate. *Inner lip*: very slightly convex on the body, it passes gradually into the short concave pillar, at the base of which there is only the faintest trace of a tooth; its edge is sharp and patulous, with a minute chink behind it. H. 0·18. B. 0·1. Penultimate whorl, height 0·06. Mouth, height 0·11, breadth 0·07.

This species slightly resembles *A. pusillus*, Forb., from the Mediterranean and North Atlantic; but the spirals in that species are stronger and are pit-marked, the suture is much stronger and more channelled, and the body-whorl is more barrel-shaped.

5. Actæon amabilis, n. sp.

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of Azores. 1000 fms. *Globigerina*-ooze. Bottom temperature 39°·4.

St. 85. July 19, 1873. Lat. 28° 42′ N., long. 18° 6′ W. Off Palma, Canaries. 1125 fms. Volcanic sand.

Shell.—Small, ovate, white, with flattened whorls, a subscalar spire, a very blunt apex, a pear-shaped smallish mouth, and a very slight tooth on the pillar. *Sculpture.* Longitudinals—there are very faint hair-like lines of growth. Spirals—there are on the last whorl about 20, on the penultimate whorl about 8 rather strong and equal furrows stippled with roundish-oval pits; they become more crowded and weaker toward the middle of the base: just below the suture the first is minutely and slightly beaded, and it with the next one or two is strong and crowded; the flat surface which parts them is somewhat broader than the furrows. *Colour* translucent and subglossy white. *Spire* conical, high, scarcely scalar. *Apex* blunt and truncated; the extreme tip is very slightly inverted. *Whorls* 5, very slightly shouldered just below the suture: round the top there is a very slight constriction; below this the whorl is conical, and in profile flat on the sides; the last whorl is a very little tumid with a produced base. *Suture* very little oblique, strongish and well marked, but not channelled. *Mouth* pear-shaped, pointed above, a little oblique in direction, patulous or very slightly guttered in front of the pillar-point. *Outer lip* straight and parallel to the axis, and a little contracted above, arched and patulous in front. *Inner lip* slightly convex on the body, on which there is a thin but distinct glaze with a defined edge. There is a slight angulation at the junction of the body and the pillar, near the base of which is a very faint tooth amounting to no more than a slight swelling; the pillar itself is very slightly oblique, and is straight, narrow, with a sharp edge, behind which is a very slight and shallow furrow. H. 0·16. B. 0·1. Penultimate whorl, height 0·04. Mouth, height 0·08, breadth 0·05.

This species is a little like *A. austrinus*, Wats.; but compared to that the form is slimmer, the whorls are more laterally compressed and less convex, the shell is smaller, and the apex is more truncated. It a good deal resembles *A. levidensis*, S. Wood, but has a shorter body-whorl and mouth; the rise of the whorls in the spire is more scalar, and the apex is stumpier with a coarser tip.

6. ACTÆON (BUCCINULUS) CINEREUS, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Strong, oblong, pointed at both ends, white, with three spiral bands of cindery spots; a high, conical, sharp-pointed spire, barely convex spirally striated whorls, a slight suture, a long narrow mouth emarginate in front, and a strongly twisted double-toothed pillar. *Sculpture.* Longitudinals—there are fine, approximate, hair-like, obsolete lines of growth. Spirals—there are on the body-whorl about 25, on the penultimate about 8, shallow square-cut furrows formed of small contiguous oval pit-marks: the flat raised surface of the shell between these is from one to three times as wide as the furrows. On the first two whorls these furrows are wanting; on the third whorl only one appears close below the suture. *Colour* porcellaneous and glossy white, with 3 narrowish bands of grey, made up of small, cindery, somewhat longitudinally arranged spots: these bands, absent on the earlier whorls, first make their appearance on the fifth, from which to the seventh there is only one band immediately above the suture; its upper edge is somewhat indefinite, flame-like expansions of it extending upwards here and there. On the body another similar band occurs at the periphery; and a third is on the base, originating just above the upper pillar-tooth; the two latter are more defined than the first: the cindery spots forming these bands are entirely absent in the furrows. *Spire* short and conical. *Apex* small and sharp, the minute tip being distinctly prominent and not in the least twisted or inverted. *Suture* slight, being scarcely impresssd; in the earlier whorls it is very horizontal, but latterly it is oblique. *Mouth* long, narrow, curved-in toward the axis of the shell, sharply pointed above, channelled in front of the pillar-point. *Outer lip* sinuated above; the lip-edge is roundly prominent at the periphery, where it is patulous, hardly curved, and in direction oblique. On the base it is extremely patulous, a little pointed, very curved and retreating; at the point of the pillar it is very strongly emarginate. *Inner lip*: the glaze on the body is not very thick, and has a defined edge which does not extend beyond the mouth; near the point of the base it is swelled into a small, narrow, blunt oblique tooth, and at the point of the pillar it forms a very strong, twisted, oblique double tooth which dies out very speedily, and does not connect itself with the mouth-edge; the furrow above the double tooth is very strong. H. 0·4. B. 0·14. Penultimate whorl, height 0·06. Mouth, height 0·28, breadth 0·08.

This very pretty little species is very like *A. glaber*, Rve., but has a higher and sharper spire, a much feebler, less channelled suture, and lacks the sculpture on the upper whorls, which in *A.* (*B.*) *glaber* are harshly pitted up to the very apex. These three smooth apical whorls are very peculiar, and distinguish the 'Challenger' species from *A.* (*B.*) *strigosus*, Gould, from Japan, the coarse apex of which is strongly sculptured. In that species, too, the upper tooth on the pillar is very feeble*. My note on the British-Museum *Buccinuli* was that some of them seemed not well individualized, especially in the case of the various specimens of *A. glaber*, Rve., *A. affinis*, A. Ad., and *A. fumatus*, Rve., and, further, that *A. cinereus*, Wats., seemed to agree with two specimens of *A. glaber* on different tablets, the one from Fiji, the other from "Sandy Cape." Mr. Edgar Smith, who kindly compared the species for me, confirms this opinion. Writing on May 2, 1882, he says:—"We have this shell marked *A. glaber*, var., from Japan; but it is probably distinct from that species."

Genus Ringicula.

1. *R. pusilla*, n. sp.
2. *R. assularum*, n. sp.
3. *R. peracuta*, n. sp.

1. Ringicula pusilla, n. sp.

September 7, 1874. Torres Straits. 3–11 fms.

September 8, 1874. Flinders Passage, Torres Straits. 7 fms.

September 8, 1874. Wednesday Island, Torres Straits. 8 fms.

Shell.—Minute, ovate, subelongate, pointed, spirally striate from end to end, with slightly canaliculate and submarginated suture and a large mouth. *Sculpture.* Longitudinals—there are very slight hair-like lines of growth. Spirals—the whole shell is scored with strongish deepish distant little furrows, which are rather more remote above than below the periphery; the first one below the suture is a little stronger than the others. *Colour* glossy translucent white. *Spire* rather high, conical, regular scalar. *Apex* small, rounded, the small tip being very little

* This observation of mine does not agree with that of Lischke, who in his 'Japanische Meeres-Conchylien,' 2ter Theil, p. 104, pl. v. f. 13, 14, says, "von den beiden Falten der Spindel ist die obere mässig." As he describes the lower one, however, as "sehr Kräftig," one may recognize from his figure that both expressions rather exaggerate the features they describe, and that his description of the upper tooth as "middling" is not materially different from my "feebler."

prominent. *Whorls* 5, subcylindrical, slightly convex, the penultimate is rather high. *Suture* canaliculate and submarginated. *Mouth* large, the teeth being small, suboblique. *Outer lip* somewhat obliquely drawn in and produced on the base, where it is round, patulous, and slightly sinuated; about the middle it is prominent and toothed; above it is narrowly and shallowly sinuated close to the body. *Inner lip* rather thinly and narrowly thickened, with a small tooth in the middle; the two pillar-teeth are oblique, parallel, and nearly equal, the lower being the larger. H. 0·067. B. 0·038. Mouth, height 0·034, breadth 0·027.

This species resembles *R. Goujoni*, de Folin, more than any I know; but the shell is shorter here, with a lower spire and a less exserted tip. The suture in that species is very much less canaliculate, the mouth is smaller, and the spirals are much less numerous and are more remote.

2. Ringicula assularum, n. sp.*

September 8, 1874. Flinders Passage, Torres Straits. 7 fms.

Shell.—Small, somewhat lozenge-shaped, the left slope of the spire and the right base, the right slope of the spire and the left base being roughly parallel, smooth and without spiral furrows, with an obtuse spire, a small but blunt apex, and a mouth much contracted by the callus of the lips. *Sculpture.* Longitudinals—there are very slight rounded lines of growth. Spirals—none, except one feeble furrow toward the front of the base. *Colour* glossy white, with a faint bluish tinge. *Spire* short, conical, very slightly subscalar. *Apex* very small, rounded, prominent, and a little elevated on one side. *Whorls* 5, conical, convex; the first, which is very small, is a little depressed, but at its origin stands up prominent on one side; the last, viewed as the shell lies on its face, is two thirds of the whole length. *Suture* strongly marked, but not impressed, nor canaliculate nor marginated. *Mouth* small, oblique, very much narrowed by the teeth of both lips. *Outer lip* very much thickened, with a large prominent blunt tooth on the inner side above the middle: there is a shallow sinus above at the junction of the lip with the body, and a very small one at the point of the pillar. *Inner lip*: there is a thick toothed pad on the body; of the two pillar-teeth

* *Pace* Captain Flinders, I have allowed myself to borrow from Plautus's rendering "*facere assulas foribus*" of our idiomatic English phrase, "to knock the door in *flinders*."

the lower, though stronger, is slightly less prominent than the upper. H. 0·11. B. 0·07. Mouth, height 0·064, breadth to outside of callus on both lips 0·058.

This species is not unlike a small *R. auriculata*, Menard; but the spire is more depressed, the apex is slightly flatter, and the extreme tip is hardly so small.

3. Ringicula peracuta, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

St. 56. May 29, 1873. Lat. 32° 8′ 45″ N., long. 64° 59′ 35″ W. Off Bermudas. 1075 fms. Grey ooze. Bottom temperature 38°·2.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Ovate, with a somewhat high conical small pointed spire, smooth and glossy, spirally furrowed below the periphery, with a marginated suture and a largish mouth. *Sculpture.* Longitudinals—the whole surface is pretty regularly scored with distinct, but not sharp, shallow furrows on the lines of growth. Spirals—just below the suture is a fine furrow fictitiously strengthened by the shining through of the superior whorl; from the periphery to the point of the base there are rather remote spiral furrows, which seem to vary as usual in number and in distinctness. *Colour* glossy white, with faint bluish tinge. *Spire* rather high, conical, scarcely subscalar. *Apex* sharp; for though the extreme tip is a little tumid, it stands well up and is rounded. *Whorls* 5, conical, slightly convex; the last is a little tumid above, but a little way behind the outer lip it becomes contracted and flattened. *Suture* distinct. *Mouth* rather large, not very oblique. *Outer lip* very oblique to the axis of the shell, slightly thickened, toothed and prominent in the middle, with large open sinus above, and a very slight one in front. *Inner lip*: there is a rather slight callus with a small tooth about the middle; the pillar-teeth, which are very far from parallel, are nearly equal. H. 0·18. B. 0·1. Mouth, height 0·1, breadth 0·07.

R. grandinosa, Hds., from the W.-African coast, is not unlike this species, but is smaller; the body-whorl in particular is much smaller, while the penultimate is larger; it is without sculpture on the base, and the upper whorls are strongly spiralled. *R. acuta*, Phil., from the Red Sea, is smaller, with a less swoln body-whorl and more tumid base; the whorls of the spire are less tumid and less exserted. *R. Someri*, de Folin, from the Cape Verde Islands, which is like in general aspect, is a much smaller, thicker, and more spiralled shell, with a less tumid body-whorl and more regularly conical spire, the slope of the whorls being more flattened; the apex, too, is much finer. *R. semistriata*, D'Orb., from Cuba, is shorter, broader, and less spiralled. *R. auriculata*, Menard, which is perhaps as like as any, has not the contracted base, and its extreme tip is 0·004 in. broad, while here the tip is 0·008 in., or half as much.

I have called this species *peracuta*, because, though certainly not very sharp, it is much more so than *R. acuta*, Phil.

On a new Peritrichous Infusorian, *Gerda caudata*.

By Frederick W. Phillips, F.L.S.

[Read April 5, 1883.]

The infusorian here recorded was found by me in water from a pond at Hertford Heath, in company with large numbers of that rather rare Rotifer *Œcistes pilula*. It is most nearly allied, and is now provisionally attached, to the genus *Gerda* (the first genus of the subfamily Vorticellina), which is thus diagnosed in Mr. Saville Kent's recently published 'Manual of the Infusoria':—

"Animalcules solitary, elongate, subcylindrical, recumbent upon, or simply adherent to, submerged bodies; not possessing a distinct sucker or specialized organ of attachment as in the genus *Scyphidia*; oral system including a peristomal border, vestibulum, and ciliary disk as in the ordinary *Vorticellæ*; increasing by longitudinal fission."

The genus at present is limited to two species. The first, *Gerda glans*, was discovered by Claparède and Lachmann in vegetable débris near Berlin, and is thus described:—

"Body elongate, subcylindrical, highly contractile, three or four times as long as broad, the wider posterior region during contraction of a cup-like form; surface of the integument transversely striate; oral aperture narrow; pharyngeal cleft deeply prolonged; endoplast ribbon-like, placed longitudinally; contractile vesicle spherical, giving off a canal-like ramification, occasionally branching a second time, and extending to within a short distance of the ciliary disk."

The second species, *Gerda fixa*, was discovered by D'Udekem in a pond in the neighbourhood of Brussels, and described in 1864 ("Infusoires de la Belgique," Mém. Acad. Royale de la Belgique, tom. xxxiv.). It is distinguished from the foregoing in having a body of greater proportional length, the surface being smooth, the body tapering abruptly, and terminating in a blunt point; the contractile vesicle is spherical and is situated close to the vestibulum.

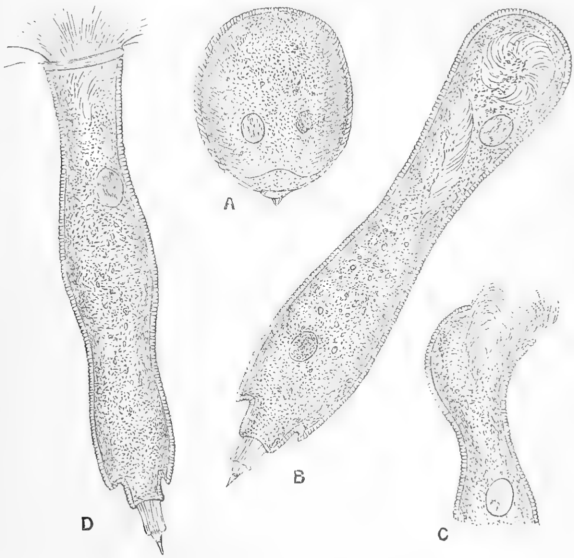
In the new species about to be described, the body is elongated, about seven times as long as broad, of an undulating contour, subject to changes; it is highly contractile, assuming a globular shape when retracted; the integument is of a reddish tint, and transversely striate, annulate when contracted. The posterior extremity of the body terminates in a peculiar imbricated tail-like appendage, resembling the telescopic tail of a rotifer, but is not telescopic; this appendage is finely striate longitudinally; the body when extended, before the ciliary disk is projected, is broad and rounded at both ends and depressed in the middle. The ciliary disk is convex; the peristome border thick; cilia very fine and long; vestibular setæ distinct; contractile vesicle spherical, situated at the extremity of the vestibular cleft; minute non-contractile vesicles distributed throughout the whole of the parenchyma; the endoplast is spherical and conspicuous; endoplasm granular, and maintains a continual cyclosis or circulation. The evertion of the cilia is extremely gradual, occupying about five to ten minutes; retraction is instantaneous. Mr. W. Saville Kent points out an analogy between the tail-like appendage and the telescopic tail of his *Vorticella telescopica.* It is proposed to bestow the specific title of "*caudata*" in allusion to this appendage.

The accompanying woodcut delineates the animal in various aspects, the same being from drawings by myself of the living object, and here greatly magnified.

Assuming the present form either to be regarded as a species of *Gerda* or closely allied to that genus, I tentatively draw out the subjoined technical diagnosis.

GERDA CAUDATA, n. sp.

Body elongate, cylindrically-undulate, seven times as long as broad, transversely striate, highly contractile, spherically-ovate when contracted, terminating posteriorly in an imbricated longitudinally striated tail-like appendage; ciliary disk convex; peristome-border thick; contractile vesicle spherical, anteriorly placed; endoplast spherical and conspicuous.—*Hab.* Pond-water.



Gerda caudata in different stages and positions. A. Retracted state. B. Extended, but with cilla withdrawn. C. Showing gradual eversion of cilia. D. Fully expanded.

On Japan Brenthidæ, and Notes of their Habits.

By GEORGE LEWIS, F.L.S.

[Read June 7, 1883.]

(PLATE XII.)

THE new Brenthidæ made known in this paper are those I acquired in Japan during the summers of 1880 and 1881, and comprise five species. The Japanese archipelago lies too far north of the equator to be rich in species of the family, yet still, in the southern island of Kiushiu and in the warm peninsula which borders on the Kii Channel, a fair number of beetles of a truly tropical type exist; and to this class the Brenthidæ noted here indubitably belong. The fact that each genus is represented by only one species is significant, and tends to show that although a few members of the family are sufficiently plastic to accommodate themselves to the climate and the other local surroundings between lat. 31° and 34°, yet there is nevertheless some physical check, which reduces their vital capital, and puts an end to that production of surplus power which would arise in a more southern climate, and, arising, would lead to further specific differentiation. There is no geographical line or barrier sufficient to exclude tropical forms from Japan; but their environment, when they reach it, prevents them from establishing themselves to any great extent; and in the southern island this is, as we should conceive, first felt in the effects of winter, rather than in those of summer, for it is to the colder period of the year we can at first trace the chief deterrent influences.

I am indebted to Mons. G. Power for his kindness to me in indicating the position of one or more of the genera; and the notes I have inserted in the text, showing the near allies of the species, are extracted from one of his letters.

1. Zemioses celtis, n. sp. (Plate XII. figs. 1, 7, 8.)

Nitidus, robustus, rufo-ferrugineus, conspicue minus sparsim hirtellus; elytris profunde striatis, striis fere esculpturatis; rostro brevissimo.

Robust, shining concolorous, clothed with long yellow-grey hairs; thorax with scattered irregular shallow punctures and a median furrow wide on the disk. The elytral striæ are broad, flat on the surface, and lightly impressed with punctures; the humeral angle is smooth. In some examples the apex of each antennal joint is piceous. Length with rostrum 3–3½ lines.

I have compared this species with Mr. Pascoe's *porcatus*, but it is not specifically allied to it. *Sebasius Deyrollei*, Lacord., is a *Zemioses*, M. Power taking *Sebasius* for those species in which the thighs go beyond the abdomen, as in *cancellatus*.

I took this species on a large *Celtis* growing on the banks of the Kumagawa, at Hitoyoshi. Specimens were passing in and out of the small holes made by *Ptinus* or *Platypus*, in a barkless portion of the tree, after the manner of the Histeridæ, *Tryponæus* and *Teretrius*, when searching for larvæ of wood-borers. When in the holes it was not possible to get at them, for though seen in the orifices, they retired when disturbed 6 or 8 inches into the tree. A child set to watch for two days collected about a dozen specimens; and later on, solitary examples were obtained in various places in Higo. This species is formed for traversing the perforations of wood-borers, but not to the same degree of eccentricity shown in the next genus, *Cyphagogus.*

2. CYPHAGOGUS SIGNIPES, n. sp. (Plate XII. figs. 2, 3, 4.)

Nigro-piceus, parcius tenuiterque hirtellus, rostro apice rufo, thorace lævi parce et grosse punctato, antennis lateraliter compressis; elytris profunde striatis, striis fortiter profundeque punctatis.

Pitchy black; head and thorax smooth and shining, latter with large shallow scattered punctures; neck and rostrum from behind the antennæ red; thorax and elytra are clothed with a few long grey hairs; elytra with smooth costate striæ, interstices rather deeply punctate; the humeral angle is smooth. Length $2\frac{3}{4}$–$3\frac{3}{4}$ lines.

This species is nearest to *C. Erichsoni*, Kirsch, which it resembles in having the first article of the hind tarsus long. This character completely separates it from *C. Whitei*, Westwood, *Westwoodi*, Parry, and *planifrons*, Kirsch.

I obtained this species in two provinces, Higo and Yamato; but, like the *Zemioses*, it was difficult to capture. In warm weather, in May and June, it may be seen slowly pacing its way over the trunks of trees with its legs widening out from the body, and the thighs moving freely as the insect walks. But this is not its usual position; it is then only shifting its quarters. The holes pierced 6 or 8 inches into the trees by small wood-borers are its chief resort; and for these cylindrical galleries they are most admirably suited, by their exceptional structure. The adaptation exhibited in this genus to a special mode of life is wonderful, and seems to point to structural modifications subsequent to, and more important than, that of the primitive *Platypi.* The anterior femora are raised up by the insect treading on the sides of the perforated passages, and thus pressed into the excavation in the fore part of the thorax, which the bulbiform part exactly occupies: the middle femora, similarly raised, fit, though indifferently, into the space between the thorax and the elytra; and the hind legs are stretched out behind, bringing the swollen part of the thigh beyond the elytra. In this position the *short* tibiæ, in the hind legs not longer than the two basal joints of the tarsus, are brought into play, while the femora are kept almost stationary, and *Cyphagogus* is enabled to enter, pass freely through, and explore the confined recesses of galleries made in hard wood by borers of no bigger girth, but of more perfect cylindricity, than themselves. Yet, on account of their elongate limbs, one might suppose, without the evidence of direct observation, that such a feat were impossible. The first and second pair of tibiæ are longer in proportion to the tarsi than the hind pair; and an examination of the insect and a reference to their habits will reveal the necessity of this structure. Look at *Calodromus Mellyi*, Guér., figured by Westwood in the 'Cabinet of Oriental Entomology,' and see what happens in an insect of these habits when the tibiæ are long. When in the confined galleries of wood-borers, the hind tibiæ of *Calodromus* cannot serve as the means of locomotion, and their apparent use seems to be to act as a mere receptacle for surplus tissue. Even when shifting its quarters, the long, flattened-out, eccentrically formed tibiæ cannot assist its movements. Owing to a knowledge of these habits of *Cyphagogus*, I took three species afterwards in Ceylon: one is very remarkable as being of a pale testaceous colour. The legs of this and *Zemioses* are delineated to show their singular form; but no drawings could be adequate for the purpose of showing their position in the trees.

3. JONTHOCERUS NIGRIPES, n. sp. (Plate XII. fig. 5, ♂; 6, ♀.)

Rufus, subnitidus, subdepressus, antennis pedibusque nigropiceis illis nigro-pilosis; elytris striatis, secundo, tertio quartoque suturali longitudinaliter depressis; subtus obscurus.

Red, smooth, and rather shining; rostrum, head, and thorax with a median furrow; antennæ and legs nearly black, former clothed with black hairs. Elytra striate, 2nd, 3rd, 4th depressed; interstices obscurely punctate. Beneath, its colour is nearly as dark as the legs. Length 3–4 lines.

♂. Antennæ slender, nearly as long as the body; eyes full, and nearly touching in front.

♀. Antennæ robust, a little longer than the head and thorax; eyes moderate, and not encroaching on the region of the head as in the male.

This species lives under bark in the same way as *Brontes* and *Dendrophagus*; the legs when at rest are kept close to the body, and the antennæ are stretched out in front and lie in a parallel position touching each other. I took about 20 specimens on the 1st May 1881 under the bark of a fallen beech, within a space I could cover with two hands. They were under rather dry bark; and in the moister parts of the same tree I found *Syntelia* and numbers of the flat bark Histeridæ. The tree was shaded by large overhanging camelias, and had been blown down by a typhoon about two years previously. I found on this occasion more females than males; but as summer came on specimens occurred commonly in Higo, and the sexes were then in proportionate numbers. The female of this genus has been hitherto rare in collections of Brenthidæ.

This genus extends to Zanzibar. I have taken it at Saigon, Penang, Singapore, and in Ceylon, and it is extremely abundant in all these places. *J. nigripes* is somewhat like *crematus*, Lacord., and *ophthalmicus*, Pascoe.

Higonius, n. gen.

Head rather large, deeply furrowed in the middle; sides rough and greatly elevated, forming over the eyes, when viewed sideways, eyebrow-like excrescences. Eyes moderate, round, visible from above; neck smooth and not conspicuous. Antennæ robust; 1st joint oval, 2nd shorter and round, 3rd rather smaller at the base, 4th to 8th short and equal, 9th and 10th larger and oval; terminal conical, and nearly as long as the 9th and 10th together. Rostrum smooth in front of the antennæ, rough, uneven, and furrowed at base. Thorax convex, smooth, rather narrowed in front, with a median furrow. Elytra subparallel, truncate at the apex, sutural and third stria much raised before the apex; striæ broad and convex; interstices feebly punctate. Legs moderate and robust.

There is apparently no difference in the form of the sexes. This genus may be placed near *Cerobates*, and the species in it probably extend over a great part of equinoctial Asia. Mons. Power has it from Penang, where I have myself taken it near the well-known waterfall; and it is with a feeling of obligation that I have named the species after him *.

* The species I took in the island of Penang I briefly characterize as *H. Poweri*, n. sp. It is very distinct from *H. cilo*, and differs in being less than half the size, surface more opaque, thorax with five, equidistant, longitudinal furrows, and the anterior femora are without a tooth. The

4. Higonius cilo, n. sp. (Plate XII. figs. 9, 10.

Rufo-testaceus, thorace peropaco, in medio canaliculato; elytris profunde sulcatis, primo fere obsoleto, ceteris fortiter elevatis, secundo ad apicem ducto, dorso nigro-maculato; corpore subtus rufo nigroque variegato.

Testaceous, very opaque; thorax divided in the middle by a deep furrow, the disk on either side being dark or discoloured; the elytra are broadly and convexly striate, with interstices punctate. In the dorsal region there is a dusky or black spot on each elytron near the suture. Legs robust, each thigh with a large tooth. Length 2–2½ lines.

This species is the largest of the genus at present known. It occurs not uncommonly under bark in the forests of Higo; and I have used the name of the province in forming the generic name.

5. Barytrhynchus Poweri, *Roelofs, C. R. Ent. Belg.* xxii. p. 65. (Plate XII. fig. 11, ♂.)

This species is allied, though not very closely, to *B. Miles*, Bohem., from the Himalaya mountains. Mons. Hiller first discovered it at Hagi, and I subsequently found it not uncommonly under bark in May in the forests of Yuyama in Higo. In June 1881 I chanced to beat a single male at Nara off a young tree.

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thoracic grooves are peculiar, and occur in no other genus in the family. Mr. A. S. Oliff has described a species from the Andamans, also with the five grooves, viz. *Higonius crux*.

Description of a new species of Higonius. *By* A. Sidney Oliff.

Higonius crux, n. sp.—Elongatus, rufo-castaneus, convexiusculus. Antennæ piceæ. Prothorax antice valde attenuatus, margine antico nigro, fortiter longitudinaliter quadricarinatus. Elytra prothorace plus quam duplo longiora, postice parum angustata; ad basin, suturâ maculâque transversâ communi pone medium nigris; quadricarinata interstitiis sat latis lævibus. Corpus subtus nitidum, læve; abdominis segmentis nigris. Pedes rufo-brunnei. Long. 3½ millim.

Hab. South Andaman Islands.

Allied to *Higonius Poweri*, Lewis, but certainly distinct. It is larger, proportionately broader, more brightly coloured, and has the ridges on the elytra more clearly defined.

6. ORYCHODES INSIGNIS, n. sp. (Plate XII. fig. 12.)

Piceus, nitidus, capite prothoraceque impunctatis; elytris costatis, sulcis regulariter grosse punctatis, signaturis flavis ad basim, ultra medium et ad apicem.

Pitchy red, shining; rostrum, antennæ, and legs somewhat paler; head and thorax smooth and impunctate, elytral striæ costate and smooth; interstices deeply impressed with single punctures, the spaces intervening between each being smooth and equal to that occupied by the puncture. The 4th stria near the base has a yellow mark covering a space equal to three punctures, the 5th a basal spot equal to two punctures; the 8th and 9th are yellow before the middle; a dorsal fascia occupies part of the 3rd, 4th, 5th, and an anteapical spot follows on 3rd and 9th. The maculation scarcely ever varies, but sometimes the 5th basal spot is absent. The ♂ has the rostrum in front of antennæ canaliculate; ♀ smooth. Size variable, $3\frac{1}{2}$–$8\frac{1}{2}$ lines.

This species, with some eastern congeners not yet described, may ultimately require a new genus for its reception. It agrees with *O. pictus*, Pascoe, and *lineolatus*, Kirsch, as regards the head and eyes, but the elytra are more like certain species of *Rhaphidorrhynchus*.

Common throughout Dai Nipon, including Sado. I do not know much of its habits; specimens were usually taken crawling over the bark of trees, or beaten, during the hottest part of summer, off saplings; and in the latter way I found it abundantly in South Yezo in August. In this and no. 5 there is no special modification in the structure of the legs; but I am inclined to believe that they often resort to, and hibernate or rest in, the larger perforations of insects such as Longicornia, or under bark of trees well loosened—spaces, that is, to which they can have easy access without special adaptation. I found, at all events, the allied genus *Arrhenodes* in Ceylon in this position, resting under large pieces of bark which came off easily in the hand. The form of *Bolbogaster ctenostomoides*, Lacord., a very interesting species of Brenthidæ, seems to proclaim its predilection for narrow galleries, as the elytra and abdomen below the humeral angle deviate from the usual parallel line in these insects sufficiently to receive the bulbiform apex of both the middle and posterior femora. I have seen a specimen in Mr. Pascoe's collection; and would call the special attention of any one studying the habits of this interesting group to it.

Trachelizus bisulcatus, Lund, Mons. Power informs me, is common in the extreme East, and that specimens have been reported from China and Japan. In the Munich Catalogue the locality given is Java; and I hesitate at present to include it in the Japan list.

EXPLANATION OF PLATE XII.

Fig. 1. *Zemioses celtis*, Lewis.
2. *Cyphagogus signipes*, Lewis.
3. Ditto, femur from above. 4. Leg, side view.
5. *Jonthocerus nigripes*, Lewis, ♂. 6. Ditto, ♀.
7. *Zemioses celtis*, femur from above. 8. Leg, side view.
9. *Higonius cilo*, Lewis. 10. Side view of head.
11. *Baryrrhynchus Poweri*, Roelofs, ♂.
12. *Orychodes insignis*, Lewis, ♂.

On the Structure of the Hard Parts of the Fungidæ.—Part II. Lophoserinæ. By Prof. P. Martin Duncan, F.R.S., F.L.S., &c.

[Read June 21, 1883.]

(Plate XIII.)

Contents.—I. Introduction: the Subfamily Lophoserinæ.—II. Genus *Lophoseris*, its Diagnosis and Details of Species.—III. Genus *Mæandroseris* and its necessary Division: Generic Diagnosis of *Plesioseris*.—IV. The Structure of the Genus *Pachyseris*.—V. The Structure of *Coscinaræa meandrina* and its Zoological Position.—VI. Remarks on the Anatomy of *Siderastræa, Merulina*, and *Echinopora*.—VII. Remarks and Considerations regarding Classification.

I. *Introduction*.—The former communication on the structure of the sclerenchyma of the Fungidæ related to the subfamily Funginæ; the present concerns the structural details of some of the compound corals belonging to several of the recent genera of the subfamily Lophoserinæ.

An examination of the recent Lophoserinæ is absolutely requisite before the classificatory position of many extinct genera of corals can be decided. Hence the examples chosen to illustrate this communication have a palæontological bearing; but I do not enter into the subject of the construction of the forms included in such genera as *Comoseris, Oroseris, Thamnastræa*, &c., because it belongs more to the province of the Geological Society; and this essay is introductory to such a one.

Very soon after this communication was commenced, I became aware that the internal structures of the compound Lophoserinæ were very varied, and that in order to illustrate the connexion of the subfamily with the Astræidæ, on the one hand, and with the Perforata, on the other, it was requisite to extend the researches and to investigate such genera as *Siderastræa*, *Echinopora*, *Merulina*, and *Coscinaræa*.

The definition of the subfamily by its authors is, "The wall is never perforated nor echinulate in the Lophoserinæ." By the wall the common basal plateau is meant; and it has been explained in the former communication (page 137) that in the other subfamily, the Funginæ, the basal wall is perforated and echinulate. The diagnosis of the Fungidæ, the family thus subdivided, is that the interseptal loculi are crossed by synapticula, which are special growths and not simple granulations. A negative character is the absence of endothecal dissepiments. Moreover the septa may be solid or more or less trabecular and perforate.

The genus *Lophoseris* is taken as a typical example, then the genus *Mæandroseris*, with collines limiting series of calices, is considered. *Pachyseris* follows as a most abnormal form, the collines being in excess; and the genus *Coscinaræa* is examined. Finally, the genera *Siderastræa*, *Echinopora*, and *Merulina* are examined. All this involves some classificatory changes and the introduction of a new genus; but the importance of the synapticula as a character of the group is enhanced.

II. *Genus* Lophoseris, *its Diagnosis and Details of Species.*

The genus *Lophoseris* of Milne-Edwards and Jules Haime replaces *Pavonia* of Lamarck; and it has somewhat unfortunately given the name to the subfamily.

"The corallum is compound, adherent, foliaceous, and usually grows upwards in irregular lobes or crests, which are covered with radiating confluent calices. Collines are present, and also keel-shaped prominences covered with septo-costæ; they are placed from below upwards along the line of upward growth of the corallum. The columella is tubercular and sometimes rudimentary. The base is finely striated"*.

Nothing is said in this diagnosis of the nature of the synapticula, of the nature of the separation between the calices, or of the existence of calices in some species on both sides of the frondiform corallum.

Lophoseris contains species which have and have not vertical

* 'Hist. Nat. des Corall.' vol. iii. p. 65, slightly altered.

collines; and in some there are none at all: the length of the septo-costæ differs greatly.

Lophoseris cristata, Ellis and Solander, sp., and *L. explanulata* Lamk., sp., may be taken as types of the crested and plain species. In the first species the calices are on both sides of the laminated corallum. The septa are not perforate, but are well developed and sharply granular at the top and sides.

The central fossa is deep, and the columella is essential, as it springs from the base of the calice and is not formed by the septal ends; it is composed of two or three rods united here and there by transverse synapticula. The septa of one calice are continued over the rounded, united margins to the neighbouring calices, and the interseptal loculi, rather deep near the fossa, become shallower externally. There is a small septo-costa between the larger ones, and it rests on the floor of the interseptal loculus which passes from the contiguous calices; this is bounded below by the tops of synapticula which are sometimes distinctly separate, and at other times formed into a solid wall. In rapidly growing calices the synapticula can be seen from above; they are large, and do not relate in any way to granulations which exist above them. There are spaces between the synapticula, when seen from above, as in *Fungia*. A section or fracture, parallel to the septo-costæ, shows rather tall synapticula, some being vertical and straight, and either narrow or broad, and others curved, short, and mostly low down. Occasionally a growth unites the synapticula, which may be parallel or not. With age, however, a distinct wall is produced between the calices and in the collines; and it is partly formed by an original vertical wall resembling a narrow synapticulum, and by the fusion of the synapticular growths on either side of it into one mass. So that in solid parts of the corallum the synapticula are not seen in series of three or four on the floor of the shallow loculi, but there is one convex mass. But as growth proceeds, traces of new synapticula are seen above the mass of the wall. The stout synapticula of the interseptal loculi are very different in appearance to the transverse synapticula between the columellary rods, which are comparatively thin; but in some parts of the calices there are thin synapticula. These are not dissepiments. Near the edge of the corallum, where growth is most rapid and the costæ are long, often slightly sinuous, and highly granular, the loculi are shallow, and there are no synapticula there;

but near the newest calices these cross structures commence as junction-structures superadded to the septa and independent of the base. Some very delicate synapticula may be seen there.

In *Lophoseris explanulata* the specimen examined gave no indications of synapticula when seen from above; only a solid wall was to be seen between the calices surrounded by the septo-costæ. Synapticula exist on either side of, and close to, the wall on the septa; and they are close and plainly visible at the very extremity of the septal interloculi. In this species, as in the other, these growths are many times thicker than granules, and have nothing in common with them.

The vertical direction of the synapticula and their considerable dimensions cause them to close much of the interseptal loculi. The growth into a structure which acts as a wall and shuts off the visceral cavities of the neighbouring corallites is very interesting.

III. *Genus* Mæandroseris *and its necessary Division.*

Genus MÆANDROSERIS, *L. Rousseau**.

A zoophytologist who only studies the recent coral-fauna would examine the species included in this genus without much interest; for it is one which at first sight falls readily into association with other Lophoserine compound corals. It comprises Lophoserines with confluent calices with distinct centres, but which are in series, the series being separated by long or short collines, over which pass the septo-costæ. A palæontologist will study the forms with great interest; for they recall the Mæandriform Lophoserines of the Jurassic age. Externally the similarity is complete; and, indeed, MM. Milne-Edwards and Jules Haime decide that the only distinction is the presence of an epitheca in *Comoseris*. An examination of the minute structures of the species is requisite before any change in the classification can be decided upon; and it adds to our knowledge of the Lophoserinæ in a marked manner, showing how closely allied forms indicate aporose and perforate affinities.

There are two species of *Mæandroseris* recorded—one the type of the genus, *M. Bottæ* of the Red Sea; the other, *M. australiæ* of the Australian seas.

The generic diagnosis of *Mæandroseris* is as follows:—

* D'Urville, 'Voyage au Pôle Sud, Zool.' t. v. p. 121.

The corallum is compound, adherent, thick, and mæandroid. The base is naked, sublobed, and finely costulate. The calices are grouped in simple linear series, and each series is separated from its neighbours by simple and low collines. The calicinal centres are distinct, and there is a papillary columella, The septa are numerous, radiate, and are very granular and "*crépus.*"

The diagnosis of *M. Bottæ* and a figure are given by Rousseau *; and the diagnosis is repeated by MM. Milne-Edwards and Jules Haime †. It refers to one specimen, and relates also to shape, which depends upon peculiar growth.

A specimen from Mergui collected by Dr. Anderson, F.R.S., indicates that the following is a correct specific diagnosis :—

The corallum is flat or slightly concave above, not universally adherent, tall or short. The base has its costal markings long and alternately large and small, finely dentated, and somewhat flexuous.

The collines bound long and short series of calices, and, on the whole, radiate from the centre to the circumference; they are broad, but high, and often show no trace of development in a special direction. The calices are shallow, the columellary space is small and deep, the columella is papillary, and the septa, often formed by the union of several, are close, confluent, subequal, stout, and granular at the sides, and warty and crisped above. There are from 30 to 40 septa. The calices are from 4 to 8 mm. in breadth, and the increase is by budding between contiguous calices.

The Construction of the Hard Parts of Mæandroseris Bottæ.—The interseptal loculi extend from calice to calice and over the collines; they are very narrow, and hence their depths cannot be penetrated by vision from above. They are widest and deepest near the calicular centres, and are narrow and shallow elsewhere.

The compound granulations on the free edge of the septocostæ are warty, broad, tall, and separate, and each one is the summit of one of the trabeculæ of which the septum is composed. These granulations extend laterally, but do not touch over the interseptal space, neither do they touch their neighbours on the same septum. They arise from more or less constricted necks.

* *Op. cit.* pl. 28. fig. 1.

† 'Hist. Nat. des Corall.' vol. iii. p. 61.

Below the granulations, and on the sides of the septa for a short distance down the interloculus, are some distinct small conical granules ; and still lower down are the highest synapticula, which nearly close in the loculus.

A section or a fracture of the coral breaks the synapticula across, and reveals the structures of the septa. These are trabeculate, especially near their free edges, are moderately stout, and consist of vertical or slightly inclined processes swollen out at regular intervals, and uniting at their sides within and without, in the proper position of the coral in relation to the calicular centre, with those next to them, by the same kind of structure. As there is some symmetry in the succession of swellings and constrictions of the series of trabeculæ, there are more or less regular, oval or circular foramina in vertical rows in the sides of the trabeculate septa. This fenestration diminishes low down, and is often replaced by parts of synapticula.

Each warty granulation on the free side of a septum is analogous to the swelling of a trabecule ; and were its sides (distal and proximal to the calicular centre) to unite, the union would represent the process which unites the trabeculæ lower down, and the involved and included spaces would mimic the fenestration. During the growth of the coral this union takes place ; and each of the successive nodules of a trabecula was once a warty granulation at the free surface of the septum.

The sides of the nodules and intervening thinner parts are ornamented here and there, and especially near to the calicular centre, with distinct granules. Amongst these, and covering more space, are small synapticula, circular more or less in fractured outline, sometimes elongate, but low (in vertical measurement), extending over more than one nodule and internodular process, and also lumpy irregular synapticula covering much of the septal surface low down, occluding fenestrations, and occupying much of the loculus.

The synapticula, varying greatly in their shape, occur between the septo-costæ of the collines, and usually the long kind predominate elsewhere, except low down, where the shape is very irregular. The absence of synapticula on the septal surfaces close to the calicular fossa is evident. *There are no walls to the calices or collines.*

Sections across the line of the septa and septo-costæ show the irregular dimensions of the synapticula and the spaces they close more or less, together with the granulations upon the nodular trabeculæ. The number of synapticula on the sides of a septum is considerable in some instances, and of course it varies with the position of the septum in the corallum.

Here and there are thin lamellar processes crossing a small part of an interseptal loculus resembling ill-defined dissepiments. In some instances they are in the line of elongate synapticulæ; but invariably a perforating annelid is close at hand. They are transverse growths. Near the calicular centre and on the flanks of the septa the granules, none of which meet across, are long, large, and in linear series. Here and there the series is replaced by a ridge which fits on to a similar one on the opposed septum, and it is a synapticulum.

The base of the corallum is imperforate, and the columellary space is open above; but it soon becomes interfered with by the nodular processes of the innermost trabeculæ of septa. The trabeculæ of the septa are arranged as if a septal lamina had been perforated after its development; they radiate on one plane, and occlusion of the foramina occurs during growth.

The collines of this species have not a true wall, nor are the calices surrounded by one. The separation is incomplete, and is brought about by a series of vertical synapticula, or by one more or less incomplete synapticulum. The first stage to a true wall is seen, as in the young of other Lophoserines (of *Lophoseris*, for instance); but fusion of the junction-processes with one another does not take place in *Mæandroseris Bottæ*.

No one can take this species for one of the Perforata, the distinction being the solidity of the base and the presence of solid large synapticula which close here and there the visceral cavity, and which are not exaggerated granules. It links the Fungidæ on to the Perforata very decidedly, and less so, however, than the genus *Coscinaræa*, which will be considered further on.

Mæandroseris australiæ, Rousseau, is the second species; but an examination of a specimen given to me some years since by the late Charles Darwin, and collected by him at Keeling atoll, still indicates that its septal and mural structures differ greatly from those of the species just considered. In fact the generic attributes of *M. Bottæ* are very evidently those given by Rousseau; but the species named *M. australiæ* cannot belong to the same genus as *M. Bottæ*, in spite of external appearance. It has a true wall running along the long axis of the collines, whatever may be their length; and the calices, even when in close series, are limited by a mural growth. The septa are not trabecular; and it is only near the columella, which is partly formed by ascending processes of their curved edges, that there is any sign of porosity. The septa join to form those of the principal orders in some parts of calices; and the synapticula are of two kinds—large, tall, and vertical near the wall; and small, short, and irregularly placed nearer the inner edge of the septa. The specific diagnosis* does not consider the internal structure in any way. "The corallum is in a convex mass, globose, and even irregularly nodular, and crested on the surface. The series of calices are short and slightly confused; and they are separated by low collines. The calicular centres are distinct. The columellary is papillary and tolerably well developed. The septa are thin, close, very crisped, and there are about 20 to a calice; they are of different sizes, and the small often unite with the larger. The breadth of a calice is 3 millim." The crisped warty spinulose granules of the free surface are very marked features. The granules on the flanks of the septa are well marked, and never coalesce.

The form comes under the genus *Plesioseris*, gen. nov., amongst the Lophoserinæ.

Corallum massive, compound, adherent, without epitheca. Surface irregular and nodular. Calices in short series confluent by their septo-costæ; centres distinct. Columella-wall developed and papillary. Septa uniting; laminæ solid except near the axial space, where ascending oblique processes are trabeculate. Granulation warty and spinulose on the free edge, distinct and separate on the laminæ. Series of calices separated by short collines; valleys moderately deep and narrow. Walls in collines and around calices. Synapticula of two kinds—one, long, broad, vertical, in two rows near the wall; another, small, nodular, near the axial space. Growth by gemmation beyond and between the calices.

The solid nature of the septa and the mural structures separate the genus from *Mæandroseris*.

IV. *The Structure of the Genus* Pachyseris.

Probably there is no genus of Zoantharia Sclerodermata which so little maintains the ordinary idea of a stony coral as

* 'Hist. Nat. des Corall.' vol. iii. p. 62.

Pachyseris. There are no separate calices to be seen; and it appears to consist of long concentric ridges separated by low valleys, the elevations being produced by vast numbers of septa placed side by side. Its species resemble corals less than those of *Mæandrina*, and yet they may be said to be mimetic types.

Pachyseris is the fullest development of the serial calicular arrangement; there are no individuals in a series, and it is all one long calice with its septa passing in one direction, over the colline, to those of the next calice in order from within outwards, and in the other sinking down along a line where there is a columellary space and perchance a columella.

The following is its diagnosis according to MM. Milne-Edwards and Jules Haime ('Hist. Nat. des Corall.' vol. iii. p. 85):—The corallum is compound, adherent, foliaceous, and very variable in shape. The collines are arranged in simple series, those of each series being completely confounded with each other. The series are separated by unequal-sized collines. The septa are delicate and close. The columella is tubercular, moniliform, and generally tolerably distinct. The basal wall is naked and finely striated.

In explanation, the authors notice that the genus contains those Fungidæ the calices of which completely unite in series, losing all individuality as in *Mæandrina*.

MM. d'Archiac and Haime described a species from the Nummulitic of Sind; and it is stated to have been found also at St. Bonnet in the French Eocene.

This form I found was a characteristic species of the Lower Eocene of Sind beneath the great development of Nummulitic limestone *.

Two well-developed species with the details on a grand scale were described from the Miocene (*Gáj*) of Sind. In one, *Pachyseris exarata*, nobis, the septa are unequal, and there is a columella; whilst in the other, *P. affinis*, the columella is rudimentary †.

Four recent species are known, and in *P. rugosa*, Lamk., sp., the septa are alternately slightly unequal and slightly enlarged near the columella; in *P. speciosa*, Dana, sp., there is more irregularity of septa and a well-developed columella; in *P. lævicollis*, Dana, sp., the inequality is evident and the columella is rudimentary; and, finally, in *P. Valenciennesi*, Edw. & Haime, the septa

* 'Fossil Corals and Alcyonaria of Sind,' Pal. Ind. ser. xiv. 1880, pl. xiv.

† *Ibid.* p. 96.

are equal, the columella but little developed, and the series are short and the valleys deep.

A species from Mergui, which resembles *P. speciosa*, so far as Dana's illustration is concerned *, and were it not for the equality of its septa would come fairly under that name, has been examined.

The structural details of the coral are remarkable; and I have never had an opportunity of examining a specimen of Dana's type. Hence I call the form under consideration *Pachyseris speciosa* provisionally, my object being to bring forward the internal structure rather than to deal with specific attributes and comparisons in this instance.

The form is in thin leaf-like shapes fixed where narrowest, and expanding on one plane, or becoming twisted up and curved. The inferior or basal surface is marked with slender costæ alternately large and small, the larger projecting slightly; they correspond with septa at the edge of the corallum which are equal in breadth. The surface is minutely granulo-spinate.

The series are very long, irregularly concentric, and bifurcating here and there. The collines are moderately deep and slightly inclined. The septa are very numerous, close, equal, thin, finely dentate where free, sometimes wavy and bent, and very granular on their sides. The columella, seen from above, fills the axial space, and unites the opposite septa in a continuous gutter.

An examination of the structures shows that whilst the lateral granulations of the septa are profuse, and occupy much of the interseptal loculi, the synapticulæ are usually not seen from above. These are sufficiently distant from the free edges of the septa not to be visible; but near the edge of the corallum, where growth has gone on lately, the bodies can be seen, and are clearly not united or fused ornamental granules.

A section through the corallum shows the thin and very solid basal lamina from which spring the septa. These are slender close to the base, equal and with well-defined interseptal loculi. The lowest synapticula are nearly everywhere at the same level at a little distance above the basal laminæ. Above the first row of synapticula the septa are broader, and, in section, their outline is very irregular on account of a succession of small ornamental granules and large synapticula and of synapticula not sufficiently developed

* Dana, 'Zoophytes, Explor. Exped.' pl. 21. fig. 7.

to meet. The synapticula are in close and regular succession in some places, are nearly as high as the septa are broad, are of course narrow on account of the proximity of the septa, and are never continuous, as in *Fungia*. Usually the synapticula are slightly dice-box shaped; and there may be from eight to twelve in a vertical series in the interseptal loculus on each side of the axis of the colline.

The collines form more or less convex projections; and as they consist of septa placed side by side and very close, it is evident that the synapticula nearly fill up the interseptal loculi. Is there a wall separating one side of the colline from the other, and reaching along its long axis from the basal lamina to near the free surface?

There is no true wall, but a long synapticulum more or less discontinuous is in the vertical line, and it is tolerably broad. The synapticula already noticed are on either side of it near the junction of the septal margins (vertical) with the columella.

The columellary structure was clearly indicated by Dana in a small drawing* of the structures of *Agaricia rugosa*, which is probably *Pachyseris Valenciennesi*. In the specimen now under consideration the columella is a mere groove above; but a section across the line of the collines and valleys shows that the columellary space is crossed by numerous tabulate-looking processes which stretch from the free edge of one septum to another. In number these processes tally almost invariably with the synapticula in vertical series; and as these last are generally on the same level in the interseptal loculi, it happens that the columellary synapticula start from the long inner surface of the level synapticula and corresponding free edges of the septa. So that long tabulæ are produced one over the other, and closing in the narrow axial space. The uppermost forms the visible columella.

The granulations on the sides of the septa are exceedingly developed in young or outer series; but it is perfectly evident that they form no part of the synapticular structures. The septa are rarely perforate.

The basal lamina is very solid, and its growth appears to be truly thecal, and not synapticular.

There are no endothecal dissepiments in *Pachyseris*; and the interseptal loculi, instead of being open down to the basal wall, are partly occluded by vertical series of synapticula; and the

* Dana, *op. cit.* pl. 22. fig. 1 *b*.

axial space is very shallow, and it is limited by the cross-bar structure of the so-called columella. The solidity of the septa is very general, and trabeculæ appear during growth and become fused eventually. It will be interesting when the soft parts of one of these species is examined, for considering how the hard parts differ from the Mæandroid Astræidæ, which have cellular endotheca in the collines and more or less perfectly solid vertical walls*. A suspicion arises that this Fungid may not belong to the same great group in the animal kingdom.

The next genus to be considered brings the Lophoserinæ in close relation with the Perforata.

V. *The Structure of* Coscinaræa meandrina *and its Zoological Position.*

The genus *Coscinaræa*, Milne-Edwards and Haime (Compt. Rend. t. xxvii. p. 496, 1848, and Hist. Nat. des Corall. vol. iii. p. 203), has been placed by the distinguished describers amongst the perforate Madreporaria in the family Poritidæ. One species is known, and it was called *Madrepora monile* by Forskål, *Meandrina* by Savigny, and *Astræa meandrina* by Ehrenberg. It clearly could not belong to either of these genera. MM. Milne-Edwards and Jules Haime named the species *Coscinaræa meandrina* (*op. cit.* p. 204); and there is a figure in Ann. des Sci. Nat. sér. 3, t. ix. pl. 5. fig. 2 (1848).

The Poritidæ of MM. Milne-Edwards and Jules Haime may be described as a family of Perforate Corals as follows:—"The corallum is compound and entirely composed of reticulate sclerenchyma which is trabecular and porous: the individuals are always intimately united either by their walls or by an intermediate reticulate cœnenchyma. The increase is by gemmation, ordinarily extracalicular and submarginal in position. The septal apparatus is distinct, but never completely lamellar, and is formed by a series of trabeculæ which form a trellis-work by their union. The walls present the same kind of base and porose structure. The visceral chambers sometimes contain rudimentary dissepiments and never tabulæ."

This important family is readily divisible into two subfamilies. In one, the Poritinæ, there is no cœnenchyma between the indivi-

* Some have a profusion of transverse endothecal dissepiments, and the wall is reduced to a narrow growth near the base.

duals; and in the other, the Montiporinæ, there is much intermediate areolar tissue.

MM. Milne-Edwards placed the genus *Coscinaræa* in the first-named subfamily, and gave the following diagnosis of it:—"The corallum is massive and composed of a hard tissue; its common base is composed of a striated lamina which appears to be imperforate and to be without epitheca. The calices are rather deep, often form little series, and increase by calicular and submarginal gemmation. There are no pali, nor are there distinct walls between individuals. The septa are numerous, close, regularly fenestrated with crumpled edges, and they merge into those of the neighbouring calices."

Coscinaræa meandrina is a recent form, and lives in the Red Sea and the Indian Ocean; and I have lately received it from Mergui. It is found subfossil on raised beaches along the Red Sea.

Klunziger, in his admirable work 'Die Korallthiere des Rothen Meeres,' vol. iii. p. 78, redescribes this species and places it amongst the synapticulate corals (1879). He restores Forskål's specific name.

Every body who handles a specimen of this coral must be struck with its resemblance to the Oolitic genus *Microsolena*, and also partly to *Mæandraræa*. Superficially there is no distinction between it and *Microsolena*; but a careful examination of its internal construction indicates that the affinity is remote, and that the genus *Coscinaræa* is not one of the Poritidæ. In fact its zoological position is amongst the synapticulate corals of the Lophoserine subfamily of the Fungidæ.

Description of a Specimen of Coscinaræa meandrina, *Ehr., from Mergui.*

The corallum is low, convex above, encrusts, and has a thin free margin.

The base, where not encrusting, is a thin solid imperforate wall or theca marked with distinct costæ, which are large and alternately large and small where remote from the margin of the corallum, and almost subequal and small at the margin, where they are continuous with the long septa of the circumferential calices. Towards the centre of the base the largest and broadest costæ become narrow projecting ridges; and here and there near the encrusting area the minuter costæ are sharply spinulose.

There is no epitheca.

The upper surface of the corallum is marked with irregularly shaped calices, short series, and slightly projecting intermediate ridges. A row of small calices is close to the margin, and the larger ones are nearer the centre. The calices are usually deep, and have a deep fossa around the small, slightly papillose columella; the septa are close, subequal, and whilst some are simple, others are composed by the union of many others. The septa of one calice pass over the low flat collines, and unite with those of other calices, or reach the margin. They are ornamented on their free edge with subequal flat spines, broad and blunt above, placed at regular and close distances; their tops are minutely spinulose. Near the wall on which the septa rest and whence they spring their laminæ are solid; higher up they are perforated in a moderate degree, and especially near the columella. On the flanks of the septa are tolerably regularly placed nodules which unite with the adjoining laminæ and are synapticula in the Lophoserine sense; that is to say, they are discontinuous, yet more or less in vertical series. They are placed on the solid and grow on the trabecular part of the septa, are in relation to vertical nodular swellings on the septa and trabeculæ, and are as stout as the septa in some places.

The growth of the corallum occurs by gemmation from the long septo-costæ at the margin, by gemmation (intracalicular) from within the well-formed calices, and also by fissiparity.

The short series have usually the calicular centres distinct, but not always; and the colline bounding the series towards the margin, or separating one series from another, is higher than the almost rudimentary eminences between the serial calices.

The longest calices are 1 centim. long and 4 millim. deep.

The nature of the basal wall, the solid structure of the septal laminæ in contact with it, the junction of the higher orders of septa with others to form large septa reaching the columella, the synapticula, and the absence of endothecal dissepiments place this form amongst the Lophoserinæ. The specimen I have examined does not show any endothecal dissepiments. But as in other Lophoserines the intrusion of parasites has developed extremely delicate endotheca near the morbid spot, but not elsewhere, this, I believe, is explanatory of the figure of them given by Milne-Edwards and Jules Haime.

VI. *Remarks on the Anatomy of* Siderastræa, Merulina, *and* Echinopora.

Genus Siderastræa, *Blainville.*—Syn. Astræa, *Oken.*

This genus, partly established by Lamarck and Blainville, is the *Siderina* of Dana, and was termed, after a careful study, *Siderastræa* by Milne-Edwards and Jules Haime. In their great work these last-named zoophytologists altered the name to *Astræa*, given by Oken in 1815.

In the diagnosis of the genus Milne-Edwards and Jules Haime state, with regard to the septa, "The sides are covered with very large granules which often meet (across the interseptal loculi) those of the opposed septa, and unite so as to form incomplete synapticula. The endotheca is rudimentary."

Pourtalès has drawn, in his 'Florida Corals,' a beautiful section of a *Siderastræa*, and shows that the calices have walls, and that there are rows of synapticula besides granules, and some endothecal dissepimental tissue.

In the species I have examined from the American and Indian seas the drawing of Pourtalès is substantiated. The synapticula are not enlarged granules, and are in regular vertical series with but little space between them when they are placed one above the other on the septa. There are granules in abundance around them and nearer the internal edge of the septa also.

Endothecal dissepiments also exist crossing the line of the synapticula; and they are normal structures, not being developed in consequence of annelid growths, as in *Mæandroseris* and other forms. The true wall separates the calices, and the interseptal loculi are intruded upon by the rows of synapticula near the wall and by the dissepiments.

Dana evidently considered this genus to belong to the Fungidæ; for he terms one species *Pavonia* (=*Lophoseris*) *Siderea.*

It is evident that the presence of endothecal dissepiments is a marked feature in this genus; moreover, the living part, when expanded, resembles that of the Astræidæ. It cannot therefore enter the Fungidæ proper, where my late friend Pourtalès proposed to place it.

Genus Merulina, *Milne-Edwards & Jules Haime.*

This genus is placed in a transition group between the Astræidæ and the Fungidæ.

The corallum is compound and more or less foliaceous, and the basal wall is perforated like that of the Funginæ. There are no synapticula, and there are endothecal dissepiments.

An examination of specimens of two species proves that this perforation of the wall is not invariable, that it does not occur in some collines at all, and that in others, where it does occur, it has not the same significance as the perforations of the wall described in the first part of this communication (see Journ. Linn. Soc. vol. xvii. pl. v. figs. 1, 2, 3, and pl. vi. figs. 3 & 6).

In some old specimens the foliaceous expansion is only seen at the margins of the corallum, and elsewhere there are calices and collines on both sides of the colony. There is no perforation in such instances; and the small foramina seen between the septo-costæ open into a dissepimental cell-space far above the wall.

Moreover, the importance of all synapticula in relation to the interloculi and their invariable presence in Fungidæ takes the *Merulina* quite beyond that family. I relegate it to the Astræidæ, especially as the transitional nature of *Siderastræa* is so evident.

The genus *Echinopora* of Lamarck and Dana was very naturally called *Agaricia* by Schweigger, for it has a very Fungid appearance. Verrill has placed the genus amongst the Fungidæ; and an examination of some specimens proves that he is correct; but I fail invariably to find synapticula, and, indeed, where I have detected them, they are very ill-developed and near the bottom of the interseptal loculi, and amongst much dissepimental endotheca. In some places the upper free edges of the septa fuse in a synapticular fashion.

VII. *Remarks and Considerations regarding Classification.*

It is evident that in the genera *Lophoseris*, *Mæandroseris*, *Plesioseris*, *Pachyseris*, and *Coscinaræa* the synapticula are important structures, not exaggerated granules, and that they may be the only means by which the septa are united and the cohesion of the corallum maintained above the solid basal wall. It is evident that they may fuse and form a false wall which may limit calices and unite the septa along collines. I do not distinguish in the recent species of the subfamily Lophoserinæ any structures which may be called false synapticula.

The synapticula occupy much of the interseptal loculi, and tend to produce canal-shaped spaces therein, more or less vertical and transverse in direction. Usually the synapticula remain separate; but in some instances they unite laterally, above and below, and form a dense structure which acts as a calicular wall. They do not form long and more or less vertical ridges on the sides of opposed septa as in Funginæ, but one synapticulum may be long and nearly sufficiently continuous to act as a wall.

The septa in the Lophoserinæ may be solid or trabecular in some parts; some bring the subfamily in relation to the Perforata; but the classificatory distinction is evident.

The calices may be surrounded by a wall, or its place may be occupied by distinct synapticula or by those which have become fused with age and growth.

A true dissepimental endotheca is not present in the Lophoserinæ. Minute growths of it are produced by disease. Hence this absence observed by Milne-Edwards and Jules Haime is significant and of classificatory value.

The family Fungidæ is really something more than a transitional group between the Astræidæ and Perforata: it has a great individuality. Although certain forms, such as *Mæandroseris* and *Coscinaræa*, ally it to the last-named group, they need not be placed beyond the Lophoserine subfamily; and they belong to it.

The new genus *Plesioseris* has a true wall, and its septa are like those of many Astræidæ amongst the Aporosa; its synapticula are well developed, and its external resemblance to *Comoseris* of the Jurassic rocks is great. There are no endothecal dissepiments. So that this genus and *Lophoseris* stand as most typical Lophoserines, and nearer the Astræidæ than *Mæandroseris* and *Coscinaræa*.

Milne-Edwards and Jules Haime wrote about the incomplete synapticula of *Siderastræa*. In 1863, in describing *Siderastræa grandis* of Jamaica (Quart. Journ. Geol. Soc. May 1863, p. 441, pl. xvi. figs. 5 *a* and 5 *b*), I noticed the synapticula; and, later on, Pourtalés gave a beautiful plate proving their true nature beyond a doubt. The genus has endothecal dissepiments; and, as in the case of *Echinopora*, this structural character removes it from the Fungidæ proper.

As *Merulina* turns out to be a serial Astræid, there is room for a group between the Aporosa, Astræidæ, and the Fungidæ; *Siderastræa* and *Echinopora* there find a resting-place.

DESCRIPTION OF PLATE XIII.

Fig. 1. The septa, base, and synapticula of *Pachyseris speciosa*. Magnified.
2. Diagram of section across colline: *a*, synapticular wall; *b*, synapticula; *c*, spaces between tabulate processes of columella.
3. *Mæandroseris Bottæ*. Septa and synapticula. Magnified.
4. The free top of a septum, showing warty ornaments. Magnified.
5. Trabeculæ, side view, granules and synapticula. Magnified.
6. Different sections of synapticula. Magnified.
7. Outline of septo-costa of *Mæandroseris*, natural size.
8. Oblique view, showing synapticula fractured on the side of the septum.
9. Diagram of a young septo-costa with mural tissue on it and synapticula on either side.
10. Synapticula between processes of the columella.
11. Synapticula fused to form a short wall.
12. Synapticula, from above. Magnified.

Mollusca of H.M.S. 'Challenger' Expedition.—Part XIX.

By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S.

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[Read May 3, 1883.]

Fam. Bullidæ, *Stol.*

Cylichna.

1. *Cylichna discus*, n. sp.
2. —— *tahitensis*, n. sp.
3. —— *crispula*, n. sp.
4. —— *noronyensis*, n. sp.
5. —— *reticulata*, n. sp.
6. *Cylichna subreticulata*, n. sp.
7. —— *labiata*, n. sp.
8. —— (*Volvula*) *paupercula*, n. sp.
9. —— (——) *sulcata*, n. sp.

1. Cylichna discus, n. sp.

St. 24. Mar. 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Culebra, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Narrowly cylindrical, truncated in front like *C. alba*; brown, with a small disk-like minutely perforated top, smooth, thin, polished. *Sculpture*. Longitudinals—there are very faint and slight lines of growth. Spirals—there are some very doubtful indications of a coarse spiral structure in the texture of the shell. *Colour* milky white and glossy. *Mouth* the full length of the shell but not more, extremely narrow, with lips nearly parallel till they diverge in front, the inner lip following the slow basal contraction, while the outer expands a very little, as is the case in *Utriculus umbilicatus*, Mont.; at the upper end is a small, narrow, but deepish rounded sinus. *Outer lip*: its edge is very straight, retreating a little quickly above and slightly in front; its direction is straight, with the very slight bend to the right spoken of above. *Top* a little contracted, rounded, with a sort of thickened pellucid disk* which is almost perfectly horizontal, so that the whole top of the body-whorl and the upper corner of the mouth are on the same level: in the centre is a minute closed pore. *Inner lip*: there is a thin narrow glaze which thickens and expands in front: it is not expanded on the top. *Pillar* is short, slightly oblique and twisted, with a strongish defined tooth, in front of which it is rather abruptly truncate. L. 0·156. B. 0·066. Mouth at same place, B. 0·014.

C. protracta, Gould, is very like this in front, but rises much higher above. *C. cylindracea*, Pennant, is slightly slimmer or narrower in proportion to length, has the body-whorl a little smaller, and the mouth slightly broader, lacks the slight posterior narrowing, and is squarely truncate behind, while here the shell is rounded. The 'Challenger' species, too, quite wants the very peculiar form of the upper corner of the mouth which is characteristic of *C. cylindracea*. *C. discus* differs from *C. macra*, Wats., in being a little broader, and having a totally different top of shell and mouth. *C. alba*, Brown, of the same size, is rounder and less cylindrical, being more attenuated above especially; the mouth is extended above the top of the shell; the top of the body-whorl is more oblique and less truncated.

2. Cylichna tahitensis, n. sp.

Sept. 28, 1875. Tahiti harbour, near the reefs, 20 fms.

Shell.—Cylindrical, thin, glassy, spirally striate from end to end, with a small body, rounded outlines, no depression nor central point at the apex, and a toothless but abruptly truncated and prominent-pointed pillar. *Sculpture.* Longitudinals—there are scarcely perceptible lines of growth. Spirals—the whole surface is covered with fine grooves not quite regular, about $\frac{1}{200}$ in. apart, but weaker and more crowded in the middle than at either extremity. *Colour* bluish transparent glossy white. *Mouth* rather large and long. *Outer lip* has a sinus just above the body,

* Hence its name.

rises and is angulated at the outer upper corner of the shell: from this point its edge advances and its line is slightly convex, tending in front to become straight; at the lower outer corner it is angulated, and across the base is abruptly truncate. *Inner lip* has a very thin glaze; it is flatly convex on the body, straight and elongately oblique on the *pillar*, which presents no tooth but has a thin, defined, hardly twisted edge, and is abruptly cut off in front, being there a strong prominent point. L. 0·083. B. 0·044. Mouth at same place, B. 0·007.

This is very possibly a young shell.

3. CYLICHNA CRISPULA, n. sp.

St. 185 *b*. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ E. Rain Island, Cape York, N. Australia. 155 fms. Sand, shells.

Shell.—Narrowly oblong, more contracted above than below, with the greatest breadth below the middle, obliquely truncate above and below, thin, translucent, glossy, very faintly spirally striate all over; the top is like that of a *Volvula*, but beside the prominent lip the axis is perforated: there is a strong pillar-tooth. *Sculpture.* Longitudinals—the lines of growth are very slight and unequal. Spirals—the whole surface is covered with very slight, superficial, fretted, rather unequal, and somewhat remote furrows. *Colour* translucent glossy milk-white. *Mouth* long and narrow above, rising and retreating at the top of the shell, widening in front, but not very large even there. *Outer lip* rises from the edge of the axial pore, and forms the top of the shell; at this point it is narrowly rounded and retreats very much, below this its edge advances and its direction is obliquely forward to the right; in front it retreats rather rapidly and sweeps freely round the base to the point of the pillar; it is a little bent in about the middle, but is very patulous on the base. *Top* is very small, and fully half of it is covered by the lip, but behind this there is a minute conical depression with a defined rounded edge. *Inner lip* is regularly arched on the body, where there is a thin glaze, which becomes thick on the pillar with a twisted sharply-defined edge. *Pillar* bears a strong, almost direct, tooth, with a well-marked broad furrow between it and the lip-edge. H. 0·16. B. 0·075. B. of mouth at same place, 0·017.

This species is deceptively like a *Volvula*. It resembles *Bulla parallela*, Gould, but is smaller, is more contracted above, and is there minutely perforated; the tooth in front, too, is stronger, and the spiral sculpture is much finer.

4. Cylichna noronyensis, n. sp.

St. 113 *a*. Sept. 1, 1873. Lat. 3° 47′ S., long. 32° 24′ 30″ W. Anchorage Fernando de Noronha. 25 fms.

Shell.—Small, oblong, broadest below the middle, narrowing to both ends, but especially upwards, thin, transparent, and glassy, rather strongly and remotely striate spirally above and below, the narrow mouth is longer than the body, the top is conically depressed, the straight, slightly oblique, scarcely toothed pillar has behind it a minute furrow and chink. *Sculpture.* Longitudinals—there are fine hair-like lines of growth. Spirals—the middle of the shell is smooth; in front there are about eight strongish remote crimped furrows: these become rather crowded on the base; above there are about four similar furrows. *Colour* hyaline white. *Mouth* long, narrow, curved throughout its whole length. *Outer lip* rises very slightly above the body, is rounded, with a very slight angulation at the outer corner, from which point to the corner of the base it is a little flatly curved; on the base the curve is rapid, and the shell is there slightly emarginate. *Top* is small, oblique, and has a conical depression in the middle behind the lip. *Inner lip* flatly curved on the body; the pillar is almost quite straight but a little oblique in its direction; there is a very faint appearance of a tooth on it in front, and behind it is a small furrow and chink. L. 0·07. B. 0·04. B. of mouth at same place, 0·01.

This may very possibly be a young shell, but among the Bullidæ it is impossible to judge whether a solitary specimen is full-grown or not. Compared with the young of *Bulla semilævis*, Jeffr., this is much slimmer in form, with a longer and smaller body, it is more narrowed and pointed at both ends, and is much more strongly and definitely striate. Compared with the young of *B. hydatis*, L., besides these same points of distinction, there is the strong curve of the line of the mouth, which in that species is nearly straight. *Atys speciosa*, A. Ad., is in form very like, but is shorter and broader, and more contracted posteriorly; and this 'Challenger' species is not an *Atys*. Something without colour between *C. marmorata*, A. Ad., and *C. bizona*, A. Ad., would be very near. *C. luticola*, C. B. Ad., is much more cylindrical.

5. Cylichna reticulata, n. sp.

St. 186. Sept. 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E. Wednesday Island, off Cape York. 8 fms. Coral-sand.

St. 187. Sept. 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E. Near Cape York, North Australia. 6 fms. Coral-sand.

Shell.—Small, oblong to subcylindrical, harshly reticulated, white, with a narrow scarcely curved mouth, a lip produced posteriorly, an oblique perforated top, a subpatulous direct and oblique pillar-lip reverted on a narrow umbilicus. *Sculpture.* Longitudinals—the whole surface is scored with strong rounded furrows, which follow the lines of growth and are parted by interstices about once and a half their width. Spirals—similar to the longitudinals, but rather stronger and further apart, are spiral furrows, the intersection of which with the longitudinals cuts the surface into square reticulations. *Colour* translucent white. *Mouth* long and narrow, widening very little in front, curved a very little throughout its whole length. *Outer lip* rises above the top, bending a little in toward the perforation; in direction it is slightly curved throughout: its edge retreats somewhat above, in the middle, and in front. *Top* is small, oblique, with a slightly expressed, narrowish, thickened, harshly radiatingly scored rim, within which is a funnel-shaped perforation. *Inner lip*: a thickish glaze crosses the well-arched body and runs out on the slightly patulous, direct, oblique, prominent, and narrow-edged pillar, behind which and half covered by it is a furrow running up into the umbilicus. L. 0·11. B. 0·05. B. of mouth at same place, 0·009.

This is a remarkable species, with very exceptional sculpture. The apical pore is so choked with impacted sand that it is impossible to say if the spire be visible or not.

6. Cylichna subreticulata, n. sp.

St. 187. Sept. 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E. Near Cape York, North Australia. 6 fms. Coral-sand.

Shell.—Small, oblong, subreticulated, white, with a narrow curved mouth, a lip slightly produced posteriorly, an oblique perforated top, a short patulous subtwisted pillar, round whose base is a slight fold, and whose edge is appressed. *Sculpture.* Longitudinals—there are irregular and not strong lines of growth. Spirals—there are coarse, but feeble, rather remote furrows which cover the whole surface. *Colour* translucent white. *Mouth* curved, a little broader above and below than in the middle. *Outer lip* rises very little above the top, bending out, a very little yet at once, from the apical pore: it is strongly curved throughout. *Top* is small, slightly oblique, with a scarcely definite feebly scored rim, within which is a funnel-shaped perforation. *Inner lip*: a thin glaze, with an irregular edge spreads across the body, which is well rounded: round the base of the oblique pillar is a feeble furrow and fold; the lip-edge is appressed, and has behind it a very slight depression, but no umbilicus. L. 0·106. B. 0·056. B. of mouth at same place, 0·013.

This species is very like *C. reticulata*, but differs from it in that the shell is broader in proportion to length; the mouth is broader and more curved; the strongly reticulated sculpture is absent, what there is being much feebler and less regular*, this is especially the case with the longitudinal furrows; the outer lip rises less high behind and does not lean in at all to the perforation; the edge of the top is less oblique; the pillar-lip has a fold at its base, and the lip-edge is reflected and appressed, and has no umbilicus behind it.

7. Cylichna labiata, n. sp.

Oct. 6, 1874. Amboyna. 15–25 fms.

Shell.—Small, strong, oval, obliquely truncate above, where the apex is impressed, bluntly pointed in front, obscurely angulated above the middle, umbilicate, finely and closely striate, with a thickened lip posteriorly produced. *Sculpture.* Longitudinals—there are fine, straight, hair-like unequal lines of growth. Spirals—there are fine spiral lines, which at the top and bottom of the shell are a little strong and remote, but in all the centre part are very faint and crowded, and above the middle, where a very blunt angulation occurs, they are nearly invisible. *Colour* translucent white, with a tinge of brown, which on the outer lip and base is ochreous. *Mouth* long, curved, narrow, a little enlarged in front. *Outer lip* rises perpendicularly from the outer edge of the impressed apex, is produced posteriorly, where it bends in toward the apex, and is patulous and almost emarginate; its direction and edge-line are both somewhat flexuous; in front it is contracted in towards the pillar, forming at the point of the base a narrow, patulous, but not emarginate,

* Hence the name.

gutter; the edge is sharp, but is strengthened a little way within by a small longitudinal rib, which is of a ruddy white colour. *Top* obliquely truncated, small, with a blunt keel round the edge of the minute, shallow, conical depression, which is half choked by the outer lip. *Inner lip*: a very thin glaze extends across the gibbously and convexly curved body; there is a slight angle at the base of the pillar, which is direct, a little oblique, hardly patulous, scarcely twisted, very narrow, most feebly toothed and truncate in front; behind the sharp edge is a small but deep umbilicus. L. 0·16. B. 0·09. B. of mouth at same place, 0·01.

This is a very peculiar form, extremely like an *Ovula* both in shape and in the thickness of the outer lip, the edge of which, however, is sharp.

8. CYLICHNA (VOLVULA) PAUPERCULA, n. sp.

St. 24. Mar. 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Small, cylindrically oblong, with a short, blunt, but pointed top, white, faintly spiralled. *Sculpture.* Longitudinals—there are fine close-set lines of growth. Spirals—the whole shell is scored with fine, shallow, remote, scarcely fretted furrows. *Colour* ivory-white. *Mouth* arched, narrow above and throughout the greater part of its length, but widening in front, where the body of the shell contracts on the base; above it rises beyond the top of the body, and in front goes slightly beyond the point of the pillar. *Outer lip* is gently curved in the middle, with a quick bend at either end; its edge seems to be nearly level, but emarginate in front. *Top* contracts rather quickly to a small central tip. *Inner lip*: a pretty distinct glaze covers the body; in front of this the narrow pillar projects somewhat obliquely, with a slight twist and prominent edge, and is rather abruptly cut off at the point; behind it lies a small furrow running up into a minute umbilical chink. L. 0·062. B. 0·03. B. of mouth at same place, 0·008.

The *V. acuta*, d'Orb. (*Bulla*), a Cuban species, is much sharper and more hunchy. *V. angustata*, A. Ad., is more cylindrical and less stumpily pointed above.

9. CYLICHNA (VOLVULA) SULCATA, n. sp.

Sept. 7, 1874. Torres Straits, N. of Australia. 3–11 fms.

St. 186. Sept. 8, 1874. Wednesday Island, Torres Straits. 8 fms. Coral-sand.

Shell.—Oblong, very symmetrically curved, bluntly pointed above, and still more bluntly in front, white, very faintly spiralled, but with the centre part of the body plain. *Sculpture.* Longitudinals—there are very slight lines of growth. Spirals—at the lower end of the shell there are about ten very slight fretted spiral furrows; those above are rather sparse and irregular, those toward the point are crowded and feeble; the larger part of the shell is plain, while above are a few spirals still feebler than those in front. *Colour* translucent white. *Mouth* arched; about the middle the arch is flattened and narrowed, broadening a very little above and somewhat more in front; above it rises bluntly beyond the top of the body, and in front it just passes the point of the pillar. *Outer lip* is very little curved in the middle, but bends in toward the axis at either end; its edge retreats a little above, but only very slightly in front. *Top* is bluntly and roundly pointed. *Inner lip*: there is a small transparent pointed pad where the outer lip rises from the tip; the curve of the body is regular, but just at the base of the pillar is a slight contraction; the pillar, which has a very faint tooth at its base, is slightly oblique, and markedly twisted out to the very point; it has a flat expanded and broadening front, with a sharp reverted edge, behind which is a rather strongly marked furrow*, but no umbilicus. L. 0·074. B. 0·034. B. of mouth at same place, 0·005.

In form this somewhat resembles *V. angustata*, A. Ad., but the sculpture is quite different. Compared to *C. acuminata*, A. Ad., the apex of the 'Challenger' species is not spike-like and the spiral striæ are stronger.

Utriculus.

1. *Utriculus* (*Tornatina*) *leptekes*, n. sp.
2. —— (——) *acrobeles*, n. sp.
3. —— (——) *avenarius*, n. sp.
4. —— (——) *aratus*, n. sp.
5. —— (——) *amboynensis*, n. sp.
6. —— (——) *pachys*, n. sp.
7. —— *oliviformis*, n. sp.?
8. *Utriculus spatha*, n. sp.
9. —— *leucus*, n. sp.
10. —— *complanatus*, n. sp.
11. —— *tornatus*, n. sp.
12. —— *amphizostus*, n. sp.
13. —— *oryctus*, n. sp.
14. —— *famelicus*, n. sp.
15. —— *simillimus*, n. sp.

* It is from this feature the name of the species is derived.

1. Utriculus (Tornatina) leptekes, n. sp. (λεπτηκής, fine-pointed.)

St. 185 *b*. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ E. Rain Island, Cape York, N. Australia. 155 fms. Sand, shells.

Shell.—Rather small, thin, oblong, cylindrical, rounded on the shoulder, very fine-pointed, with sinistral upturned apex, narrowed in front, spirally striate, with long, narrow, slowly widening mouth. *Sculpture.* Longitudinals—the lines of growth are very slight and regular. Spirals—the whole surface is scored with sharp-cut fine furrows, which are about half the width of the interstices; round the top of the whorls runs a slight but sharp-edged axial keel. *Colour* almost hyaline white from the extreme thinness of the shell. *Mouth* a little shorter than the shell, very elongately and slightly curvedly pear-shaped, rather narrow above and there channelled. *Whorls* 3, besides 1½ in the sinistral embryonic apex. *Outer lip* very gently curved; its edge-line retreats very much above and in front. *Top*: there is a very short scalar spire, in which the first regular whorl is elevated and is truncately conical, the second hardly shows above the third; in the middle rises the small sinistral, more than half-turned-over apex; the sutural canaliculation is a shallow rounded furrow, with a sharp-edged external border carinating the whorls. *Inner lip*: there is a thin but distinct labial pad; the curve of the body is convex, and contracts slowly from the top of the mouth to the front, which is not truncated: the pillar is long, oblique, with a small reverted lip and a very slight long-twisted tooth, behind which is a feeble furrow, caused by an impression made in the shell. L. 0·14. B. 0·06. B. of mouth at same place, 0·02.

This species differs from *U. acrobeles*, Wats., in its narrower form and thinner texture, in its sculpture, in its larger mouth, in its spire, its sutural canaliculation, and its apex, which is more prominent.

2. Utriculus (Tornatina) acrobeles, n. sp. (ἀκροβελής, ending in a point.)

Shell.—Rather small, spirally scored, oval, subcylindrical, bluntly rounded in front, with a low subscalar spire crowned with a minute prominent sinistral apex turned up on its side. *Sculpture.* Longitudinals—there are faint growth-furrows drawn at the top into short very oblique folds. Spirals—the whole surface is scored with fine furrows, which are remote above but closer in front, where the intervening surface is rounded; a rounded keel lies below the suture. *Colour* translucent white. *Mouth* markedly shorter than the shell, straightish, clavate to pear-shaped, narrow and channelled above. *Whorls* 4, exclusive of $1\frac{1}{2}$ of the apex, which are sinistral. *Outer lip* straight, very slightly appressed above, where it is separated from the body by the slight shallow sutural canal. *Top*: there is a short distinct subscalar spire, in which the first regular whorl hardly shows, but which is crowned with the small sinistral half-turned-over apex. *Inner lip*: there is a thin but distinct labial pad; the curve of the body is nearly straight, but is convex in front; the pillar is very oblique, broad, flat and patulous, with a very broad, scarcely twisted tooth, which is longitudinally furrowed so as almost to be double: in front of this tooth the pillar is truncated at its junction with the outer lip. L. 0·13. B. 0·055. B. of mouth at same place, 0·014.

This species differs from *U. avenarius*, Wats., in the shape of the shell and of the spire, and in the apex and pillar. *U. canaliculatus*, Say, is much stumpier and has a lower spire. The upturned apex is like that of *Odostomia lactea*, Linn.

3. UTRICULUS (TORNATINA) AVENARIUS *, n. sp.

April 17, 1874. Port Jackson, Sydney. 2–10 fms.

Shell.—Oval, rounded bluntly in front and sharply above, where the papillary apex projects, smooth, angulated above round the outside of the channelled suture, with a strongly toothed, twisted, and oblique pillar and a smallish mouth, which is shorter than the shell. *Sculpture.* Longitudinals—there are faint rounded furrows on the lines of growth. Spirals—on the upper part of all the whorls there seem to be close-set very faint spirals; about the middle of the whorl they become stronger, like very fine remote furrows; a bluntly angulated keel projects axially below the suture. *Colour* translucent white. *Mouth* a good deal shorter than the shell, conically clavate, slightly curved, a little blunt at the top. *Whorls* 4 to $4\frac{1}{2}$, angulated above; each rises distinctly above the one which follows. *Outer lip* almost appressed above, but separated by the deep sutural channel which runs into the top of the mouth: in front it is very

* So called from its having somewhat the appearance of a grain of oats.

patulous, and obliquely truncate backwards; in the middle it is slightly contracted. *Top*: the whole upper part of the shell contracts, and the spire is roundly conical and subscalar, with the glossy round papillary apex rising slightly above all: it is scored with the sutural canal, which is narrow and not deep, but well defined by the sharp keel which lies below it. *Inner lip*: there is a thick prominent labial pad; the curve of the body is convex, and so passes on regularly to the point of the pillar, which is very oblique and carries a strong, twisted, oblique, longitudinally furrowed tooth; between this tooth and the body is a very small furrow. H. 0·22. B. 0·1. B. of mouth at same place, 0·02.

This species a good deal resembles, not the *U. turritus*, Möll., but Sowerby's figure of that species in the 'Thesaurus,' pl. cxxi. f. 28. In perfectly fresh specimens the spiral furrows, which I have described as very faint, may be distinct; but in the ten 'Challenger' specimens they are only traceable with certainty near the edge of the labial pad. *U. canaliculatus*, Say, is a much smaller and stumpier form, much broader above, with a minute apex turned over on its side.

4. UTRICULUS (TORNATINA) ARATUS, n. sp.

St. 188. Sept. 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E. W. of Cape York, off S.W. point of Papua. 28 fms.

Shell.—Small, oblong, truncated at the top, rounded in front but not truncated, with whorls sharply angulated above and furrowed spirally from end to end*, a channelled suture, a papillary apex, a longish, concave, toothed, and furrowed pillar, and a small mouth. *Sculpture.* Longitudinals—the lines of growth are very feeble. Spirals—from end to end the shell is scored with small but distinct furrows, which on the front of the shell are rounded, but above are sharper, shallower, and fretted; they are parted by flattish surfaces of double their width in front, but much more than this above, where the furrows are slighter: round the top of each whorl runs a sharp up-standing keel, within which lies the deepish and narrow, but at bottom rounded, sutural canal. *Colour* ivory-white, with a dull gloss. *Mouth* barely shorter than the shell, narrow, curved, slowly enlarging, elongately pear-shaped. *Whorls* barely 3. *Outer*

* Hence the name.

lip almost appressed above, but separated by the sutural canal; it does not rise quite to the top of the shell, it is very slightly arched, and the edge is scarcely curved, and is hardly emarginate in front. *Top*: the shell is narrowed and then sharply and flatly truncate; round the edge and coiling in to the centre is a sharp but not expressed keel; the whole interval between the keel of one whorl and that of the next is occupied by the sutural canal, which has a convex slope on the interior side, a rounded bottom, and a perpendicular face on the exterior whorl; the central tip is a (relatively) large, glossy, translucent, flatly rounded prominent dome. *Inner lip*: there is a very thin glaze across the slightly arched body; round the base of the straightish concave pillar coils a strongish tooth, minutely furrowed longitudinally, and with a sharp twisted inner edge; outside the tooth-edge is a strong furrow with a minute umbilical chink. H. 0·083. B. 0·041. B. of mouth at same place 0·011.

This species very much resembles the following, but may at once be distinguished by the top.

5. Utriculus (Tornatina) amboynensis, n. sp.

Oct. 6, 1874. Amboyna. 15–25 fms.

Shell.—Small, oblong, truncated at the top and a little so in front, with whorls sharply and expressedly angulated above, and very faintly spiralled, a channelled suture, a minute regularly incoiled apex, a shortish, oblique, toothed, and feebly furrowed pillar, and a small mouth. *Sculpture.* Longitudinals—the lines of growth are barely visible. Spirals—a little way below the middle a minute and very shallow furrow is found; below this, at about five times the breadth of the furrow, is another similar, then at half the distance below is another furrow, after which others succeed, becoming more crowded and slightly stronger on to the point of the shell; above there are none of these furrows, only round the top of the whorls runs a sharp keel expressed by a rounded furrow on its outer side and by a deeper and stronger furrow on its inner side. *Colour* translucent glossy white. *Whorls* $3\frac{1}{2}$. *Mouth* barely the length of the shell, narrow, straight, small, enlarging quickly, but to no great extent. *Outer lip* rather thick, almost appressed above, but separated from the body by the sutural canal; it reaches the top of the shell, but retreats a good deal at this part; its edge line is curved and it is contracted at the middle, in front the edge retreats and is subemarginate on the base, where it is considerably thickened by the extension of the pillar-tooth, which is continued round the front within the edge of the lip, and separated from the edge by a minute furrow. *Top*: the shell is slightly contracted, and then sharply and flatly truncate; round the edge and coiling in to the centre is a sharp, expressed keel, the whole interval between one keel and the next is occupied by the deep, perpendicular-faced sutural canal, the horizontal top of the whorl, and the extracarinal furrow; the apex is perfectly flat, and is minute and regularly in-coiled. *Inner lip*: a strongish glassy defined callus runs down the rather cylindrical body, disappears in the extracolumellar furrow, and reappears in the extreme edge of the outer lip; a strong oblique tooth twists round the base of the pillar, is flattened back on the pillar, and is continued in a small intralabral callus on the base; behind the pillar-edge is a strongish but shallow furrow, but no umbilical chink. H. 0·083. B. 0·042. B. of mouth at same place, 0·009.

This species is at first sight, and especially in rolled specimens where the sculpture is effaced, deceptively like *U. aratus*; it is really, however, quite different, and in particular the difference may at once be recognized in the top of each. The species seems considerably to resemble *B.* (*Tornatina*) *polita*, A. Ad., from Manilla, but the lip is not posteriorly produced.

6. Utriculus (Tornatina) pachys, n. sp. (παχύς, broad.)

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

Shell.—Rather large, gibbously oval, being tumid in front and contracted upwards, truncated above where the edge is carinated and furrowed, with an impressed top and a papillary apex. *Sculpture.* Longitudinals—the lines of growth are few, sinuous, and very slight. Spirals—round the edge of the impressed top is a rounded keel, with an exterior strongish rounded furrow, outside of which is a narrow sharpish keel; within the apical pore the whorls are sharply keeled above the channelled suture; the only other trace of spiral striation is behind the outer lip, where the fresh shell shows some trace of a spiral texture. *Colour* horny yellowish white. *Mouth* club-shaped, large, the full length of the shell, being a little produced posteriorly, shortly curved across the body, ample in front. *Whorls* 4, the earlier ones only indistinctly visible in the impressed top; the apex is papillary. *Suture* deeply channelled, with a sharp keel above it: this keel runs out not above but on the edge of the funnel-shaped top. *Outer lip* rises from the inner side of the apical depression and slopes flatly outwards, forming thus the patulous opening of the funnel-shaped depression; at the apical keel it is angulated; from this point it makes a convex sweep, which has a slight contraction about the middle; it is patulous and somewhat elliptical in front. *Top* nearly flat, only the outer lip rises slightly above the level; the apical depression is funnel-shaped, having a wide converging mouth and a small, not deep, hole in the middle, with a papillary apex in the centre. *Inner lip*: a broadish distinct white glaze extends across the body, on which the curve of the lip is very regularly convex on to the narrow, long, low, and twisted pillar-tooth; beyond this the pillar-lip is slightly concave, narrow, a little patulous, and appressed. L. 0·23. B. 0·14. B. of mouth at same place, 0·04.

I do not know any other *Utriculus* so rounded in its outlines as this; it is also very broad relatively to its length.

7. Utriculus oliviformis, n. sp.?

St. 73. June 6, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of Azores. 1000 fms. Bottom temperature 39°·4. *Globigerina*-ooze.

This large and very interesting species is in too bad condition for satisfactory description. I had called it *oliviformis* from its shape, which is peculiarly stumpy, with an excessively short and broad mouth, and an unusually high and blunt spire; it is sharply fretted all over with sharp lines, and has a strong little furrow behind the sharp-edged twisted pillar. It is like *U. culcitella*, Gould, or *U. lactuca*, Nevill, in its conical spire; and like *U. simplex*, A. Ad., in shortness of body. *Tornatina olivula*, A. Ad., is much slimmer, longer in mouth, and much more cylindrical. It differs from *Utriculus spatha*, Wats., in its greater breadth, higher spire, shorter mouth, coarser sculpture, more numerous whorls, and more abrupt truncation in front, where the shell is cut off almost at right angles to the axis. L. 0·32. B. 0·17. L. of mouth 0·2; B. 0·05.

8. Utriculus spatha, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Large, cylindrically oblong, gradually and slightly narrowing forwards, more abruptly so up the short stumpy and very blunt spire, thick, exquisitely reticulated, with a truncated and toothed pillar and a straight slightly contracted outer lip. *Sculpture.* Longitudinals—the whole surface is delicately and sharply scored in the lines of growth with very fine rounded furrows parted by sharper and much narrower ridges, which are about $\frac{1}{1200}$ of an inch apart. Spirals—a little stronger than the longitudinals, which they cut across, are spiral lines very distinct above, one or two on the shoulder being even strong and remote, more delicate and similar to the longitudinals in front, and in the middle very faint indeed, only sufficient to produce a satiny sheen; round the top of the whorls below the suture is a very broad shallow furrow or slight constriction bordered by a very feeble keel below, which forms a vague shoulder. *Colour* ivory-white. *Mouth* $\frac{5}{6}$ of the whole length of the shell, in shape somewhat clavate, being shortly broad in front, elongately conical throughout most of its length, and rapidly contracted at the top. *Whorls* $2\frac{1}{2}$, rounded above with a very slight concave constriction below the suture, subcylindrical in the middle and rounded in front. *Suture* linear, impressed, and very slightly horizontally margined below. *Outer lip* contracted and appressed above, so that the top of the mouth runs up to a long and very narrow point, bluntly angulated at the shoulder, below this it is straight, but draws in towards the axis, in front it is patulous and well rounded; the edge line is convex, and retreats very rapidly in front, where the shell is abruptly truncate. *Top* very bluntly rounded, the apex being to some extent enveloped in the succeeding whorl, which rises slightly above it. *Inner lip*—a thick pad of glaze, with well-defined edge, extends down the slightly convex body, and passes with gradual sweep into the twisted subconcave pillar, which is truncate in front; at the base of the pillar the glaze is much thickened, and presents for a short distance two very oblique twisted parallel folds, which are parted by a small furrow; another furrow lies outside, between the exterior fold and the glaze-edge. L. 0·3. B. 0·14. Mouth: L. 0·25; B. 0·03.

This exceedingly peculiar form in many respects recalls, rather than a *Utriculus*, one of the long narrow low-spired *Marginellas*, such as *M. Nevilli*, Jouss., or *M. avena*, Kien.

9. Utriculus leucus, n. sp. (λευκός, white.)

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of Azores. 1000 fms. *Globigerina*-ooze. Bottom temperature 39°·4 Fahr.

Shell.—Strong, cylindrical, with a very slight upward taper, rounded at either end, with an oblique flat apex and a minute perforation round which the edge of the penultimate whorl is visible, and in the middle the sunken apex; the mouth is small and narrow, and in front abruptly truncate, with a short truncate very bluntly toothed pillar. *Sculpture.* Longitudinals—there are slight unequal furrows on the lines of growth. Spirals—the whole surface is most faintly and doubtfully marked with very feeble furrows, which are both narrow and superficial, parted by broadish flat interstices. *Colour* translucent white, with a faint brownish tinge, glossy. *Mouth* long, narrow, shorter than the shell, straight, with parallel sides, the enlargement in front sudden, but very short. *Outer lip* straight, rounded above, where it springs from the callus of the inner lip; it does not rise so high as the opposite side of the apex, which consequently is rather oblique; its edge line is slightly produced in the middle, but not bent in; in front the lip, in common with the whole shell, is very abruptly truncate, and here it sweeps round with a strong, sharp, bevelled edge to join the pillar-lip. *Top* roundly flattened down and slightly bent in round the small apical perforation, round which 1½ to 2 whorl-edges are visible. *Inner lip*: across the body runs a strongish callus, whose edge exactly corresponds with the edge of the outer lip; in front it is flatly and broadly appressed on the very stumpy pillar, round which twists a strongish but very blunt tooth. H. 0·25. B. 0·11. B. of mouth at same place, 0·03.

This species is very like *Cylichna alba* *, Brown, but it is squarer both above and below; the obliquity of the line of the top is exactly the opposite of that in *C. alba*, where, from the outer lip rising above the top of the shell, the greatest height is at the

* The similarity, indeed, suggested the name.

mouth; while in *U. leucus* the top is highest on the side away from the mouth.

U. vortex, Dall, seems to present several points of resemblance; but that species seems to taper much more toward the tip, to be differently and much more strongly sculptured, to have no pillar-tooth, and to be very much broader in proportion to length (4·25 millim. to 7·5 millim.).

The *Tornatina eximia*, Baird, has a more perfectly cylindrical form, a higher spire, and a much wider mouth.

10. UTRICULUS COMPLANATUS, n. sp.

St. 188. Sept. 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E. West of Cape York, off S.W. point of Papua. 28 fms.

Shell.—Minute, cylindrical, truncated and flat on the top, very much and obliquely truncated in front, with whorls angulated above and furrowed longitudinally and spirally, a papillary apex, a longish pillar, and a club-shaped mouth. *Sculpture.* Longitudinals—the furrows on the lines of growth are strong and curved. Spirals—the whole surface is scored by sharp irregular furrows parted by flat intervals of about three times their width. *Colour* white. *Mouth* the full length of the shell, narrow above, oblong and roomy in front, club-shaped. *Whorls* 3; on the top of the shell they are rounded. *Suture* slightly impressed. *Outer lip* rises roundly the least thing above the top; its course is straight, with a very slight concavity; its edge is prominent. *Top* perfectly flat, with a roundly angulate edge; the individual whorls are rounded, and are parted by a somewhat impressed suture; the central tip, which is glossy, is papillary, but depressed. *Inner lip* is, on the body, slightly concave in its course; the pillar is oblique, nearly straight, and is patulous. L. 0·05. B. 0·028. Breadth of mouth at same place, 0·013.

This is a very small species, the solitary specimen of which is not in good condition. It is a good deal like *U. truncatulus*, Brug.; but the sculpture is a very marked feature of difference and the form is more stumpy.

11. UTRICULUS TORNATUS, n. sp.

St. VII. Feb. 10, 1873. Lat. 28° 35′ N., long. 16 5 W. Teneriffe. 78 fms. Coral.

Shell.—Small, cylindrically oblong, a little tumid in front, slightly narrowed backwards, rounded at the shoulder, longitudinally and spirally striate, with a flat top, a small papillary apex, and straight club-shaped mouth. *Sculpture.* Longitudinals —there are many fine, rounded, feeble lines of growth. Spirals —there are many very faint minute superficial spiral lines which owe somewhat of distinctness to the colour, and to the fact that at somewhat regular intervals there occurs one a little stronger than the rest. *Colour* transparent white, irregularly banded with unequal spiral milky stripes, which are obsolete in many specimens. *Mouth* club-shaped, the full length of the shell, long and narrow above, slightly enlarged at the top, considerably so in front by the contraction of the body-whorl at the base. *Whorls* 3, far from distinct, slightly rounded, of very gradual increase; the extreme apex is minute, but papillary. *Outer lip* rises very slightly above the flat crown, and here it is very patulous and almost emarginate; just where it begins to run forward it is very slightly expanded, from this point to the base it advances quite straight and a little inflected; on the base it is freely rounded, truncated, and patulous. *Top* is barely oblique, and the rise of the outer lip elevates that side, so that the whole top is almost flat, with more or less of a depression in the middle where the minute dome-shaped apex rises. *Inner lip*: there is a strong well-defined labial glaze which runs quite straight and continuously from the outer lip across the scarcely convex body, and passes on with a quick deflection to the left into the slightly concave, scarcely toothed, oblique, truncated pillar, where the lip is narrow, expanded, and appressed. L. 0·092. B. 0·046. B. of mouth at the same place, 0·005.

This is a species extremely abundant at Madeira, where I dredged many thousand specimens. They vary somewhat in the relation of length and breadth, and still more in the form of the crown, which is sometimes flat and broadish, with an impressed suture, at other times narrow, with a small deep opening and a very depressed apex, the suture in these circumstances being out of sight.

12. Utriculus amphizostus, n. sp. (ἀμφιζώστος, girt in.)

Sept. 8, 1874. Flinders Passage, Cape York, N. Australia. 7 fms.

St. 186. Sept. 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E. Wednesday Island, Cape York. 8 fms. Coral-sand.

St. 187. Sept. 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E. Near Cape York. 6 fms. Coral-sand.

Shell.—Small, rather broadly cylindrical, but contracted in the middle, and broadest below the contraction, very bluntly rounded in front, longitudinally striate and very finely spiralled, with a flat but slightly depressed crown and a small papillary apex. *Sculpture.* Longitudinals—there are a great many small hair-like ridges and furrows on the lines of growth; they are nowhere strong, but are feeblest on the base. Spirals—the whole surface is very equally striated, with delicate shallow scratched lines parted by flat surfaces 4 or 5 times the width of the lines; there is a very slight and gradual constriction, most apparent near the outer lip, about the middle of the body, and in front of this the shell is slightly tumid. *Colour* translucent white, with vague trace of spiral bands. *Mouth* the full length of the shell; shaped like a racket, being oval in front, long and narrow above; it is small and rounded at the top, which just rises to the crown. *Whorls* 4, of which only the small rounded tops are seen on the crown, where they are slightly and radiatingly ridged, the last envelopes all the others. *Suture* impressed and distinct. *Outer lip* rounded at the top, where it does not rise above the crown; it runs straight and parallel to the inner lip till below the middle, where it bends outwards in exact symmetry with the corresponding bend of the inner lip on the base, forming a very regular oval curve in front; the edge line is regularly curved, retreating slightly behind and in front, and advancing in the middle where the lip is contracted. *Top* flat, but slightly depressed, with a small papillary apex in the middle, the outer edge is roundly angulated. *Inner lip* straight down the body, concave on the pillar, which has a very slight twist and a narrow patulous edge, behind which is a scarely appreciable umbilical depression; the point of the pillar projects in front clear of the sweep of the basal curve. L. 0·12. B. 0·06. B. of mouth at same place, 0·02.

This species is very like *U. truncatulus*, Brug.; but that has much stronger longitudinals, no spirals, and its crown is oblique, sloping down from left to right, on which side the top of the mouth and outer lip rise in a rounded loop very considerably above the top of the body-whorl.

13. Utriculus oryctus, n. sp. (*ὀρυκτός*, excavated.)

St. 344. April 3, 1876. Lat. 7° 54′ 20″ S., long. 14° 28′ 20″ W. Ascension Island. 420 fms. Hard ground.

Shell.—Subcylindrically oblong, truncate above, where the crown is sharply angulately edged and excavated, with a papillary apex, tumid below the middle and rounded in front, obsoletely striate in the lines of growth. *Sculpture.* Longitudinals—the ordinary ridges and furrows in the lines of growth are feeble, except on the crown, where the old lip-edge scars are strongish, close, and hair-like. Spirals—none, except that round the edge of the crown there runs a sharp angulation in continuation of the outer lip. *Colour* ivory-white, somewhat streaked longitudinally. *Mouth* a little longer than the body, and at the top, to a small extent, enlarged, slightly curved on the inner side, and there in front gibbous; on the outer side it is nearly straight. *Whorls* 3: the last encircles all the rest, which only appear on the crown, where each rises above its predecessor in a round-faced curve; the first is papillary and immersed, the last rises above on the margin in a sharp edge and is a little tumid in front. *Suture* slightly impressed. *Outer lip* rounded and cut off backwards above, angulated at its upper outer corner, straight with a slight median contraction, rounded and patulous in front; its edge line is very regularly curved. *Top* deeply excavated, with a sharp edge. *Inner lip*: there is a very thin glaze; the line across the body is much curved, the narrowing forward of the body beginning early and being considerable; the pillar is very oblique, subtruncate, very bluntly and faintly toothed, with a narrow expanded sharpish-bordered edge, and an almost imperceptible umbilical chink behind it. L. 0·13. B. 0·07. B. of mouth at same place, 0·01

The very sharp outer rim of the crown in this species is characteristic. The species slightly resembles a large and stumpy *U.* (*Cylichna*) *umbilicatus*, Monterosato, but is posteriorly squarer and more truncate, the whole top is different, the line of the pillar is straight in its obliquity, not roundly hollowed, and there is no spiral sculpture.

14. Utriculus famelicus, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Long, narrow, subconically cylindrical with straight outlines, abruptly truncate above, with a deeply impressed papillary apex, and rounded slightly tumid in front, harshly striate above and delicately so below. *Sculpture.* Longitudinals—the lines of growth are very slight, but round the top of the shell is a coronal of folds forming ridges and furrows of about equal strength; these extend over the top and into the hollow crown. Spirals—round the top, harshly scoring the coronal, are 4 or 5 deep, but not broad, sharp-cut furrows, parted by flat surfaces of about twice their breadth; below these, to a fourth of the length, there are distant furrows so obsolete as to be almost invisible; below this the whole surface is superficially scratched with delicate sharp-cut fretted furrows parted by broadish flat intervals. *Colour* translucent white. *Mouth* the entire length of the shell, being considerably produced posteriorly, where it is slightly enlarged; in the middle it is narrow, the two sides being almost perfectly parallel, in front it is elongately oval; in its entire shape it resembles a spoon. *Whorls* 4, but the earlier ones are so deeply sunken, and the hole in the crown (where alone they are visible) is so small, that it is difficult to count them; the apex is papillary. *Suture* slight. *Outer lip* rises straight from the crown, with a slight inclination in towards the centre, is narrowly rounded above, and advances straight for about two thirds of the shell's length, at which point it is slightly expanded, and then becomes somewhat patulous; it sweeps rather freely round to join the pillar. *Top* small, oblique, harshly radiatingly striate and deeply narrowly impressed. *Inner lip* long and straight, slightly convex in front, oblique and slightly concave on the pillar, which is bluntly toothed in front, and has a very narrow scarce patulous prominent edge with a minute furrow behind it. L. 0·18. B. 0·06. B. of mouth at same place, 0·019.

This species, whose thin and famished look suggested the name chosen, belongs to the group of which the Mediterranean *U. striatula*, Forb., may be taken as a type, though in that the features attributed to the subgenus *Sao* (of *Cylichna*) are much more strongly developed. Compared to this species of the 'Challenger,' *Cylichna fijiensis*, E. Sm., is broader, not squarely truncate above, and not so plicate round the top of the body. *U. phiala*, A. Ad., from Japan, is not nearly so long and narrow, and is more cylindrical. *Cylichna decussata*, A. Ad., which is like in sculpture, is shorter, less cylindrical, and the outer lip rises much higher behind. *C. pyramidata*, A. Ad., which is puckered above, is much less cylindrical and is smooth in the body.

15. UTRICULUS SIMILLIMUS *, n. sp.

Sept. 7, 1874. Torres Straits, North of Australia. 3–11 fms.

Sept. 8, 1874. Flinders Passage, Cape York, North Australia. 7 fms.

St. 186. Sept. 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E. Wednesday Island, Cape York, North Australia. 8 fms. Coral-sand.

Shell.—Small, short, truncately conical, with straightish outlines, a perforated crown, and a small papillary apex, rounded and tumid in front. *Sculpture.* Longitudinals—the lines of growth are very slight; but round the top of the shell is a coronal of delicate folds forming ridges and furrows of about equal strength; these extend over the top and into the perforation of the crown. Spirals—round the top is a slight but marked constriction; above this the top converges, and is finely scored with small close-set furrows; the rest of the shell is superficially scratched with delicate, sharp-cut, fretted, remote furrows parted by flat surfaces: on the base the furrows are closer and coarser, and the intervals rounded. *Colour* translucent white. *Mouth* the entire length of the shell, being considerably produced posteriorly, where it is enlarged; in the middle it is narrow and slightly bent, in front it is large and oval. *Whorls* 3 to 4; the apex is papillary, but very small, and so deeply immersed as to be doubtfully visible. *Suture* very difficult to distinguish, but apparently impressed. *Outer lip* rises from the inner side of the perforation and bends in over it, so as partially to cover it: it arches freely round and is not at all emarginate; for about three fifths of its length it runs pretty straight forward, at this point it is slightly constricted, and contracted, but immediately bends to the right and curves very regularly round the base, where it is patulous. *Top* contracted, rounded, oblique, harshly radiatingly striate, and deeply narrowly impressed. *Inner lip* convex, tumid in front, oblique and slightly concave on the pillar, which is feebly toothed, and has a very narrow, scarcely patulous, prominent edge, with a minute furrow behind it. L. 0·1. B. 0·047. B. of mouth at same place, 0·024.

This species greatly resembles the young of *U. famelicus*, Wats., but is very much broader in proportion to its length. *Cylichna fijiensis*, E. Sm., is much larger and slimmer.

* So called from its resemblance to the young of *U. famelicus*, Wats.

Mollusca of H.M.S. 'Challenger' Expedition.—Part XX.

By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S.

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[Read June 21, 1883.]

Fam. Bullidæ (*continued*). Fam. Aplysiidæ.

The group belonging to these two families, so far as already overtaken, is a small one, comprising only three genera with five species. All the species, however, are of great beauty and interest.

Fam. Bullidæ, *Stol.*

1. Gen. Atys.	2. Gen. Scaphander.

Atys, *Montf.*

Atys hyalina, n. sp.*

July 29, 1874. Levuka, Fiji. 12 fms.

St. 186. Sept. 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E. Wednesday Island, Cape York, N. Australia. 8 fms. Coral-sand.

St. 187. Sept. 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E. Near Cape York, N. Australia. 6 fms. Coral-sand.

Shell.—Oval, subgibbous, a little abruptly contracted and slightly constricted and truncated above, striated, thin, hyaline, umbilicated, with a largish curved mouth. *Sculpture.* Longitudinals—there are very many slight equal hair-like lines of growth. Spirals—with the exception of a narrow nearly median band, which is smooth, the whole surface is scratched with fine smooth regular square-cut widely parted furrows. These are rather more regularly arranged above than below, where the interstices are more wide and less regular; but toward the end of the shell in both directions the furrows tend to become crowded; they extend to the very edge of the funnel-shaped depression of the apex; but the depression itself is smooth except for the twisted edge of the outer lip, which is reverted as usual, but somewhat narrowly at the generic sinus: in front they score the umbilicus on one side, but do not quite extend to the edge of the pillar. *Colour* hyaline to translucent. *Mouth* long, curved, rather narrow, and not much enlarged in front. *Outer lip* convex,

* Not *Bulla hyalina*, Gm.

posteriorly produced; the generic twisted sinus is rather small; above it the lip rises and advances, and forms a sharp curve: from this point the lip runs out to the right, at first straight or faintly concave, and here a little contracted, but afterwards with a very regular curve, and increasingly patulous to the point of the shell. *Top* very obliquely truncate, with a bluntish edge and a small funnel-shaped depression, which, through the generic sinus, leads into the interior of the shell. *Inner lip*: there is no glaze on the body, the curve of which is a little gibbous above: the pillar-edge is narrow, reverted, bluntly toothed, twisted, and truncated in front; at the base of the pillar this edge is very much twisted, and is there separated from the body, leaving a very narrow but deep fissure communicating with the deep umbilicus which lies behind, and is partly covered by the expanded and projecting pillar-edge. H. 0·44. B. 0·24. Breadth of mouth at same place 0·07.

I do not know any *Atys* with which to compare this very beautiful and delicate species. It has something of the gibbosity of *Atys cylindrica*, Helb., var. *solida*, in its stumpiest forms; but the texture of the shell, the sculpture, and the umbilicus are very different. The specimens from St. 186 and 187 are quite young shells, but are, I have no doubt, this species. From Honolulu, 40 fms., there is a specimen of *Atys* probably belonging to this species, but in too bad condition for identification with any certainty.

Gen. SCAPHANDER, *Mont.*

1. *S. mundus*, n. sp.
2. *S. niveus*, n. sp.
3. *S. gracilis*, n. sp.

1. SCAPHANDER MUNDUS, n. sp.

St. 191. Sept. 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E. Off Arru Island, W. of Papua. 800 fms. Fine sand. Bottom temperature 39°·5.

Shell.—Obliquely oval, above narrowed obliquely, concavely truncated, and on the right bluntly pointed; below rounded, thin, opaque, ivory-white, glossy, stippled in spiral lines. *Sculpture.* Longitudinals—there are very fine hair-like lines of growth with slight irregular interrupted and unequal undulations. Spirals—the whole shell is covered with small shallow distant impressed dots: these above are roughly rounded or obliquely longitudinal;

but from about one third of the way down they become transversely elongate: they are arranged in rows not quite equal, and which are parted by intervals of fully double the breadth of the dotted rows: towards the point of the base the dots tend to return to the round shape, and the rows of largish dots are parted by rows of minute transversely elongated dots which occur in the intervals. Besides these, there are over the whole surface the close-set superficial microscopic spiral lines, which seem to be a characteristic of the genus. *Epidermis* excessively thin, membranaceous, and glossy, of a faint straw-colour. *Colour* ivory-white. *Crown* oblique. There is a slight indentation or small conical pit almost completely coated with the glaze of the lip: this little pit is encircled by a very slight and blunt keel. *Mouth* irregularly pear-shaped, being somewhat narrowed above and expanded below. *Outer lip* projects a little angularly behind, and here it is reverted, thickened, and appressed: from the highest point of its rise it sweeps round to the point of the pillar with a very equable curve; it is very patulous on the base. *Inner lip* flexuous, being very convex on the body and openly concave on the pillar. A very thin glaze extends from the outer lip above across the body to the pillar, which has a pretty strongly reverted rounded and twisted edge, up which one can just see into the interior of the shell for nearly two turns. H. 1·15. B. 0·78. Greatest breadth of mouth 0·61.

This is a delicately beautiful shell, curiously intermediate between *S. lignarius*, L., and *S. punctostriatus*, Migh., while perfectly distinct from both. In form it is less like a *Bulla* than the latter, while the attenuation above is less, and the expansion of the outer lip below is even greater than in the former. Lying on its face, it is broader and is more flattened, and that, too, more obliquely than either. Its puncto-striate spiral sculpture approaches that of *S. punctostriatus*, Migh.

2. SCAPHANDER NIVEUS, n. sp.

St. 214. Feb. 10, 1875. Lat. 4° 33′ N., long. 127° 6′ E. S.E. of the Philippines. 500 fms. *Globigerina*-ooze. Bottom temperature 41°·8.

Shell.—Thinnish, obliquely oval, slightly narrowed and rounded above, where the outer lip rises on the right like a tooth; in front it is rounded with a very blunt angulation at the point of the pillar; ivory-white, glossy, striate, but scarcely stippled.

The body is rather tumid, and shaped like a *Bulla*. *Sculpture.* Longitudinals—there are exceedingly faint hair-like lines of growth, of which, at frequent intervals, one more distinct produces a slight undulation of the surface. Spirals—the whole shell presents the microscopic and very superficial crimpings of the genus, which become rather strong on the base ; there are also some very superficial and extremely obsolete bandings or furrows and ridges, which are scarcely appreciable. Besides these, the upper half of the shell and the point of the base are scratched with fine square-cut striæ, which, with a little difficulty, can be recognized as formed of minute contiguous stipplings : these are very remote in the middle of the shell, but towards either extremity they become crowded. *Epidermis* membranaceous. *Colour* white with a faint ivory tinge. *Crown* consists only in the flatly rounded margin of a very small pit-like depression in front of the origin of the outer lip, which rises abruptly above the top of the shell. *Mouth* curved, rather club- than pear-shaped, being gibbously enlarged in front and elongate and rather narrow behind. *Outer lip* thickened, reflected, and sinuated above, where, curving forwards, it rises in a tooth-like form above the crown ; from this point it sweeps very equably round to the point of the pillar, the curve being very slightly flattened above, and somewhat full on the base : it is patulous throughout : the very thin edge is nowhere very prominent. *Inner lip* roundly convex on the body, bluntly angulated at the base of the short scarcely curved and barely truncate pillar. A thickish and rather prominent glaze joins the two extremities of the outer lip : near its edge on the upper part of the body this glaze has a few irregular rounded tubercles : on the base, where it is thickened to a pad, these tubercles increase in size and number, while the reverted pillar-lip is harshly covered with them. The pillar-lip is not quite closely appressed, having an overhanging edge and a closed chink behind it. H. 1·15. B. 0·8. Greatest breadth of mouth 0·56.

Having only one specimen of this species under examination, it is impossible to say whether the roughening of the labial glaze is a specific feature, as in some of the Volutes, or the result of disease. In this species the general form of the shell, and especially that of the body-whorl, is even liker a *Bulla* than is the case with *S. punctostriatus*, Migh. ; but the apex is not perforated. As in that species one, looking up the pillar, can only see a single complete whorl. The minute stippling of the spirals resembles, on a still smaller scale, that feature in *S. lignarius*, L. Compared to *S. mundus*, Wats., this is a much more tumid form, and the sculpture is markedly different.

3. Scaphander gracilis, n. sp.

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of Azores. 1000 fms. *Globigerina*-ooze. Bottom temperature 39°·4.

St. 78. July 10, 1873. Lat. 37° 26′ N., long. 25° 13′ W. Off San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

Shell.—Thinnish, oblong, slightly flattened, a little narrowed upward, obliquely truncate at the top, where the outer lip rises like a tooth on the right; in front it is a little oblique toward the right, very little expanded, rounded towards the point. The mouth is pear-shaped and small for the genus. *Sculpture.* Longitudinals—the lines of growth are very slight. Spirals—the whole surface is dotted over with fine remote stipplings somewhat variable in size and shape, running in rather oblique spiral lines, which are a little crowded above and distant in front, where, however, an additional finer line of minute stipplings is often intercalated. *Epidermis* membranaceous, pale lemon-yellow. *Colour* dead white, with occasional translucent longitudinal bands. *Crown* consists of the bluntly rounded edge of a small shallow round pit, which is partly or wholly choked up with the labial callus: the line across the crown is very oblique. *Mouth* rather small, pear-shaped, and nearly straight. *Outer lip* slightly thickened and reflected on the crown of the shell, from which it rises upwards and projects forwards like a tooth: from this point it advances almost straight with a patulous and scarcely convex edge to the beginning of the base, whence it sweeps round, retreating and very patulous, to the point of the pillar. *Inner lip* very slightly convex above, almost straight in its oblique course across the base; on all this part a thickish well-defined glaze is spread: on the front of the body, as the mouth begins to widen, this glaze is pressed out into a blunt angulation, almost a tooth, which is prolonged to the left in the narrow-edged, flat-fronted, truncated, twisted, concave pillar: here the reverted callus, which dies out at the point of the pillar, has behind it a small shallow flat furrow leading up into a pore-shaped umbilicus. Looking up the axis of the shell, though the opening is rather narrow, two whorls can be distinguished. H. 0·62. B. 0·34. Greatest breadth of mouth 0·24.

This is a long and narrow shell with little of the generic peculiarity of shape, though the anterior splay form is recognizable. The singular thickening of the pillar seems to increase with age. In the three specimens from St. 78 it is much more strongly marked than in the somewhat younger shells from St. 73. The young shells of *S. punctostriatus*, Mighels, are squatter, rounder, with a flatter crown, and have the outer lip less produced behind; their stippled sculpture, which varies a good deal, is often coarser, and forms more continuous spirals; the pillar-lip, too, and shape of the body are very different. In one of the St. 78 specimens in particular the slow wasting away of the surface has scarcely attacked the stippled pits of the spirals, which accordingly remain projecting as flat round tubercles.

Fam. APLYSIIDÆ, *d'Orb.*

Gen. DOLABRIFERA, *Gray.*

DOLABRIFERA TRIANGULARIS, n. sp.

Oct. 29 to Dec. 16, 1873. Simon's Bay, Cape of Good Hope. 10–20 fms.

Shell.—Much arched, corrugated, porcellaneous, dull, and scored on the upper surface with sharp strong lines of growth, on the under surface lustrous and amorphous, with a strong but irregular oblique longitudinal furrow and rough radiating lines toward the back; it resembles the blade of a fleam, being triangular, with a straight back, the handle (where the nucleus is) in front, and the point (a bluntly rounded one) on the left. Round the nucleus there is an amorphous expansion and thickening; across the blade obscure and unequal rays diverge from a point behind the nucleus. The back of the blade is thick and blunt, the other two sides bluntly bevelled to a sharp edge. H. 0·43. B. 0·21. Height of the arch 0·1. Greatest breadth behind 0·3.

This species is much more attenuated in front than *D. marmorea*, Pease, from the Sandwich Islands, which otherwise it much resembles in form and texture, whilst it is in sculpture much more delicate. *D. Maillardi*, Desh., from the island of Bourbon (see 'Moll. de Bourbon,' p. 53, vii. 20–22), is much more regular in shape, more like the seed of our common plane (*Acer pseudoplatanus*), with a regular-shaped wing and a head or nucleus continuous with the body instead of, as here, a fleam-like blade and distinct handle.

Japanese Languriidæ, with Notes on their Habits and External Sexual Structure. By George Lewis, F.L.S.

[Read November 15, 1883.]

(Plate XIV.)

The first notice of Japanese Languriidæ appeared in the January number of the 'Entomologist's Monthly Magazine' in 1873; since then one species has been described by Von Harold in the M.T. Münch. ent. Verein. iii. p. 59, and during my late visit to Japan in 1880 and 1881 I obtained five new species, bringing the total up to 15, as under:—

Doubledaya bucculenta, n. sp.

Section I.

Languria ingens, n. sp.
—— pectoralis, *C. Waterh.*, ♀.
convexicollis, C. Waterh., ♂, nec Bohem. 1860, nec Horn. 1867.
sodalis, C. Waterh.
Waterhousei, Crotch.
—— nigritarsis, *C. Waterh.*
? *unicolor*, Motsch.
—— Lewisii, *Crotch.*
—— geniculata, *Harold.*
Languria nara, n. sp.
—— columella, n. sp.

Section II.

Languria atriceps, *Crotch.*
—— ruficeps, *Crotch.*
—— fucosa, n. sp.
—— prætermissa, *Janson.*

Section III.

Languria filiformis, *F.*
nigripes, Crotch.
—— præusta, *Crotch.*
Microlanguria Jansoni, *Crotch.*

Languria unicolor, Motsch., appears, with some doubt, as a synonym in the list; because, though it seems probable that Motschulsky's description was drawn from what is now either *nigritarsis* or *pectoralis*, his measurements are misprinted "$1\frac{1}{4}$ by 1 line:" for this and other reasons it would be but guess-work to apply his name to either of the species.

The highest point north of the equator in which any member of this family has been found is in latitude 46° in Siberia (*L. Menetriesi*); there are none in Europe, but I have a species from Egypt. In Japan three are found in lat. 43° and ten in lat. 33°; and as the climate in the south is evidently favourable to them, and some are local, we may still look for additions to the present list. If the Languriidæ do not certainly emanate from the tropics, it is clearly within an area of a thousand miles of the equator that they meet with the climatal environment which is most essential to their welfare and specific multiplication; and in this respect resemble somewhat the Brenthidæ, of which a few species also inhabit Japan. Of the few northern Languriidæ which overstep this line by 1200 miles, and to which these notes relate, comparative diminutiveness in size and sombreness in colour are the most striking characteristics; and the same may be said of the species of the United States, which reach as high as lat. 42° or 43°. We observe also that the Japanese species agree in facies and general outline with the forms in equinoctial Asia; and in the western hemisphere it is also true that the dominant types of the American continent are found south of Mexico. Harold has pointed out that *Languria nigripes*, Crotch, = *filiformis*, F.; and in the British Museum there are examples of the latter from Sumatra, Java, Luzon, and China; and of the little *Microlanguria Jansoni* I have specimens which I took at Colombo, one of the hottest places in the island of Ceylon. Here are two species therefore which are common both to Japan and to countries lying under, or close to, the equator. All this suggests a tropical origin as probable for these species, an hypothesis which may perhaps be extended also to their allies. *Languria præusta* probably occupies as wide an area of distribution as *L. nigripes*; I have myself taken it at Yokohama and in Hongkong, places distant from each other by an ocean-line of 1500 miles.

In the Munich Catalogue, 1876, there are only 114 species of Languriidæ given; and Harold, in the paper cited, describes in 1879 about 40 more; yet the total, say 160, can be but a small portion of those existing in nature, or even actually now extant in our collections. Harold merges *Pachylanguria*, *Tetralanguria*, *Fatua*, *Callilanguria* (allied to *Doubledaya*, figured here), and Crotch's other genera in *Languria*; and thus reduces the whole family to one genus, because it is at present an insufficiently studied group and requires revision. My own investigation leads me to accept Crotch's genera, and even to suggest one more. Crotch's *Languria Jansoni*, with "coarsely granulated eyes, elongate antennæ, 3-jointed club, and short tarsi," I have called *Microlanguria*. *Languria Mozardi*, Latr., from Texas, is the type of the genus *Languria*; and the points of dissimilarity between it and those in Section I. of this note, to which the Japanese *L. ingens* belongs, are more than sufficient to found a genus on, if the members of the group were numerous enough to render this desirable. I think also that *L. trifoliata*, Harold, may well be separated later, as it is one of a section having a peculiar form and structure, of which there are many species in Ceylon, the individuals of which, while usually clinging to foliage, are, when disturbed, instant in flight.

In the imago state some of the Languriidæ mount and cling to the stems and leaves of brushwood; others sit on the foliage of various biennials and perennials growing in the moist and half-shaded parts of forest; and some smaller species, often having blue elytra and a red thorax, frequent hillside débris, such as may be likened to haystack-refuse. Those on the low herbage may be swept off and obtained in abundance in the right localities; and the prevailing colour of the species of this habit is æneous or brassy green. This is all that was known about the habits of the Languriidæ until a notice appeared by Prof. J. H. Comstock in the Annual Report of the Department of Agriculture, Washington, 1879, where he traces the life-history of *Languria Mozardi* from the egg to the emergence of the imago. As his observations well deserve the notice of entomologists on this side of the Atlantic, I have thought it well to copy them *in extenso* :—

"In localities where this beetle is abundant, if the stems of red clover be carefully examined some time in June, on many of them will be seen one or more small discoloured spots, which seem to have been made by the gnawing of some insect. If one cuts into the stems at one of these spots, a slender yellowish egg 1·7 millim. (about $\frac{1}{16}$ inch) long, rounded at both ends, and somewhat curved, will be found imbedded in the pith, the gnawing having evidently been done for the purpose of penetrating the comparatively hard exterior and allowing the egg to be easily pushed in. Often the egg is found as far as 6 millim. (nearly $\frac{1}{4}$ inch) from the opening, which shows that the mother insect must have forced her whole body into it.

"The larvæ hatching from these eggs are slender, almost worm-like in form, and feed exclusively upon the pith of the stalk. While they do not kill the stem outright, they gradually weaken it, and eventually cause its destruction, having also, of course, a very injurious effect upon the maturing of the seed. The egg is usually laid high up in the stem, and the larva usually burrows downwards, often extending its work for a distance of from six to eight inches below the point of entrance. The full-grown larva is about 8 millim. ($\frac{3}{5}$ inch) in length, yellow in colour, with six prominent thoracic legs, and a prop-leg at the posterior end of the body. The last segment of the body has two stiff, slightly upward-curved spines above. Upon attaining full growth, the larva transforms to a pupa in the lower part of the burrow The pupa is about 6 millim. long, slender, with a large head, and is yellow in colour. The adult beetles begin to issue in August, and are continually making their exits until late in October.

"There is probably but one brood in a season, and the insect hybernates in the beetle state. An examination of many stalks during the winter failed to show the insect in any stage of growth."

Figures are given of the egg, larva, pupa, imago, and the stem of the clover with the larva feeding in it.

It seems obvious from this notice that the mode of life during the larval state connects the family rather with the Chrysomelidæ than with either the Erotylidæ or the Endomychidæ; and I must confess that my own observations of their general habits in Eastern Asia, where I almost daily saw examples of the commoner kinds, led me to place them near the Endomychidæ. Prof. Comstock's remark that "the larva usually burrows *downwards*, often extending its work for a distance of from six to eight inches below the point of entrance," shows it to be an internal feeder on living vegetation. If it ascended the stem above the orifice, it might be open to suggestion that a fungoid growth (on which Languriidæ have been supposed to feed) had commenced in the dead clover-stem; but this is clearly not the case. Prof. Comstock's observations also show us the reason of the parallel and unexceptional elongate form of the Languriidæ, in so far as we see this form is suited to the position of the imago before its egress from the hollow stem in which it has attained to maturity.

I think we must, after reading Prof. Comstock's paper, look at the Languriidæ as a, comparatively speaking, recent type of Coleoptera, nearer to the Chrysomelidæ than to the Erotylidæ, which has greatly multiplied its species, but which has, as yet, owing to simple and constant habits, been evolved in the direction of growth of the longitudinal axis only.

In the large families of Coleoptera, *e. g.* Carabidæ, we have convex and ovate forms, as *Omophron*, elongate figures in *Casnonia* and *Scarites*, and flat mouldings in *Morio*. Histeridæ have shapes corresponding to the above in *Saprinus*, *Tryponæus*, and *Dimalus* or *Hololepta*. Again, in the Chrysomelidæ, *Gastrolina* is a flat species which hybernates under *Planera*-bark, and convex and linear species of the group are familiar to all. It is only natural to look upon these forms in all the large sections of Coleoptera as the result of the complex agencies which must arise in, and are inseparable from, compound evolution. But in the opening life of a young group greater simplicity is, on the other hand, equally to be expected. Where we observe great diversity of form, there we see equal diversity of habit, as in the Carabidæ and Histeridæ; but at present we see neither one nor the other in the Languriidæ.

In a *Cucujus* the larva and pupa are flat, like the imago; the first and second stages are entirely passed under bark, and the third stage also in the greatest part. In *Gastrolina* above noted, a genus which stands next to *Chrysomela*, the larvæ and pupæ are of the ordinary gibbous form of the family, and feed on, in the first stage, and are suspended to, in the second, walnut-leaves. It is not until the imago appears that the insect is *flat*, and in condition to join the *Cucujus* and winter under the bark of the *Planera*. Even a gravid female could not hybernate under the close-fitting bark; but copulation takes place on the fresh foliage of spring after hybernation. Here is a singular fitting of a species for special environment during one stage; but it is only conspicuous to a Coleopterist, because it is unusual in the leaf-eating family of Chrysomelidæ. The phenomenon, however, prevails throughout the whole of the Lepidoptera and other orders, but, being general in them, attracts less attention.

As far as the Languriidæ are concerned, we can believe that, if they are all reared within a stem, or any enclosure of like capacity, as Prof. Comstock's observations may lead us to suppose probable, it will account for their acquiring the elongate form, which is at present the only form known to us in the family, and of their retaining it. If they should eventually prove, as a group, to be so constantly and invariably elongate as our museums, with slight exceptions, at present exhibit them, they must be either a recent divergence and undifferentiated, or the elongate form, when once acquired, answers the requirements of the insect's life better than any other shape, and has been acquired in a fairly simple life, which form inactivity and sluggishness of habit has confirmed rather than modified.

In the Heteromera there are analogous forms, both to the Languriidæ (*Dolichoderus* is like *Fatua*) and to the Erotylidæ (*Acropteron*), and this is the case in many other groups; so that we cannot say that there is any special modification in any one of these families beyond what their mode of life and its environment would lead us to expect. By analogous forms I mean forms agreeing in facies, with an approximate structure of appendages, these correspondences being evidently connected with the habits and surroundings of the species, and primarily caused by the conditions under which they exist. In the *Languria trifoliata*, Harold, already referred to, we have an outline which is, for this group, very considerably modified—"elytris post basin subampliatis," with the apex opening or dehiscent. This insect is so quick on the wing that it is difficult to capture.. Here is a difference in habit accompanied by a corresponding deviation of form, and evidently in some way correlative.

It cannot be said that the fashioning of the Languriidæ is the result of influences affecting the insect in some early stage (as larva or pupa) before the imago appears, because we see throughout the whole of the insect world that in each stage of an insect forms are assumed which are adapted solely to such stage, and are entirely free and uncontrolled by any external structure of the individual during any antecedent stage of its existence. Each, as a larva or imago, is formed for its environment to crawl or fly, and a process, which is not immediately obvious, checks in all its stages variation or an abrupt departure from the type of its predecessor.

I say acquiring and *retaining* their form, because, owing to the continuity of action in all natural forces which produce a permanent effect on the structure and composition of any animal, we cannot separate the creative from the preservative process.

A reference to a certain phase in the Vegetable Kingdom will illustrate my meaning. I take an Oak as the ordinary type of growth in a plant under normal conditions. In a full-grown tree the greatest circumference is in the part just above the root, the part which is half in, half out of the ground. This part represents the first growth in the acorn, which maintains a proportional bulk throughout the lifetime of the tree. The growth of vegetation in England is checked in autumn by the falling temperature, and the circulation in the tissue of a tree is stopped in all its parts (in a climate where growth is slow) almost at once. But let me picture an area nearer the tropics, such as many travellers have seen, in which during part of the year copious rain falls, and is then abruptly followed by a lengthened period of drought. With the drought the temperature rises, the sun and wind scorch the foliage and upper parts of the tree or plant, while a porous soil below drains the roots. The thick part of the tree or palm still retains a certain moisture, and, stimulated by the heat, continues to grow. An environment of this kind would cause a proneness to enlargement above the roots in many vegetables existing within its area; and as long as these conditions were fulfilled, this phenomenon would be a noticeable feature in the landscape. What I have roughly delineated here is a process which is, I believe, the origin of the bulbous forms of vegetation, whether it be that of a hyacinth, an onion, or a stunted oak. But who would doubt that, if the climate of this area changed, became, as it were, more like Ceylon, with continuous rain, this bulbiform habit which I have depicted would disappear, and in time be eradicated altogether by the plants resuming a more constant and uniform activity in all their parts. The dryness of this area at one period of the year is the illustration of the "creative" and "preservative" cause I wish to notice. The periodical dryness after luxuriant rain which originated the bulbous habit must continue to recur, otherwise it disappears. A small *Scilla* on Wimbledon Common is subject to these dry conditions as I describe in August; and in Japan, the home of the Liliaceæ, there is a long dry winter season (Ent. Mon. Mag. xviii. pp. 5–7), which has a great effect there on both animal and vegetable life.

The above illustration may serve to show what "reversion," commonly so called, is to my mind. All ideas of reversion appear to me to be greatly at variance with the doctrine of evolution. But let us suppose that an actual Ceylonese climate takes possession of the area spoken of. What happens? The plants would resume their growth, as I have suggested, in all their parts, and their globosity would disappear. Yet we could not call this reversion; for in reality there is no retrograde movement, although the second condition of these plants may be more like those forms from which they originally arose, or are supposed to be derived.

Sometimes entomologists, when they observe a succession of likenesses, such as those here traced in plants, in animals widely separated from each other in a system of classification, set the phenomenon down as originating through "natural selection" producing a resemblance which is supposed to be "protective," forgetting the while that like causes produce like effects, and cannot in this material world of ours act otherwise.

The process I have spoken of as checking variation appears to me to be akin to that enunciated by Spencer as "organic polarity" in his Chapter on "Waste and Repair;" and it is to this process I also think can be traced the manifestations which are usually regarded as phenomena of heredity. For if we say a certain family of plants (Begoniaceæ) possesses a certain polarity, we cannot refuse to admit that each species within that family has its own peculiar polarity. A step further leads us to say that each individual of a species has its individual polarity; and it is these individual distinctions or peculiarities, which we observe in organisms of the closest affinity, that are called phenomena of heredity. I think it would be as wrong to say that "organic polarity" was inherited as it would be to say that alum in water inherited a form of crystallization.

The new species are, as I have said, five in number; but I have added some remarks on others, in the order of the list, which the observation of external sexual characters renders necessary.

DOUBLEDAYA, *White*,

is a genus allied to *Callilanguria*, Crotch, and possesses some of its characters. Antennæ about as long as the head and thorax; joints 1–7 nearly equal, 8–10 dilated, 11 subovate; eyes moderate, granulate, and rather prominent; thorax rather convex above, longitudinally impressed, immarginate in front; elytra parallel at sides, truncate at the apex, twice and a third longer than the head and thorax, with the apical fold padded beneath with a short whitish pubescence.

The following sexual characters were not noticed by White or Crotch:—

Male. Head wide, robust at the neck; cheeks angulated and swollen to receive mandibles; left side much larger than right. The growth of the head affects the position of the antennæ and the eyes, and forms a frontal disk for them; eyes smaller than in the female. Thorax subquadrate, rather broader than long; basal angles acute. Legs elongate and simple; anterior tarsi very amply dilated, posterior tarsi much less so, middle tarsi intermediate between the other two.

Female. Head moderate, not distorted neck narrowed, being rather less than the head at the region of the eyes; eyes, viewed from above, project clearly beyond the outline of the head; thorax one third longer than broad; legs one third longer than in male, with only slight variation in the dilatation of the tarsi, all approximate to those of the middle pair of legs in male.

Note. The thorax of the female is much longer than in the male, and a generic character is that the antennæ are about as long as the thorax. The female has therefore, what is unusual in Coleoptera, longer antennæ than the male; and there is apparently some correlation between the length of the thorax and that of the antennæ.

Mr. Bates possesses a species of this genus from Assam, and I have another from the Andaman Islands. The described species, *D. victor*, White, and *D. Whitii*, Crotch, are from Madras and Sumatra respectively.

DOUBLEDAYA BUCCULENTA, n. sp. (Plate XIV. figs. 1, 2, 3.)

Supra omnino obscuro-ænea vel nigro-picea, subnitida; antennis pedibusque nigris, thorace in medio profunde canaliculato, circa canaliculam fortiter punctato, angulis posterioribus acutis, elytris fortiter punctato-striatis, interstitiis perleviter corrugatis; subtus nigra, abdomine undique punctato. Long. 12 ad 19 mill. ♂ capite latere sinistro valde angulato (fig. 3), thorace subquadrato, tarsis anticis dilatatissimis. ♀ thorace latitudine longiore.

Obscure brassy green, or more rarely pitchy black; the head and thorax at the sides have a few fine irregular punctures. The thorax is canaliculate in the medial region, and this furrow is occupied by larger and deeper punctures; the posterior angles are acute, and rather more produced in the male than in the female.

The curious sexual characters traced here are uniform and generic. At first sight the enlargement of the left side of the head in the male looks like a monstrosity; but it is merely another instance of that asymmetry which has been observed in the mouth-organs of males of species in several families. One-sided prognathism occurs also in *Callilanguria* ♂, and in the British Isles there is one instance of it in *Agathidium rhinoceros.*

I obtained this species *in copulâ* in Idzu in May 1880 and the year following in Higo; it is not common, and my series consists of only twenty examples. The specimens were beaten off brushwood mixed with bamboo which overhung mountain rivulets in well-shaded forests. This and the two following species are never found far from water, and are most about during the wet season, when the climatal conditions in South Japan closely resemble those of a tropical atmosphere.

The thick pubescence or padding beneath the apical fold of the elytra would act, if necessary, to prevent water from entering the space between the elytra and abdomen; but my observations are too limited to allow me to do more than hint at the use of this structure. If the mandibles of the male are used for gnawing bamboo after the manner of *L. Mozardi* in clover, they would mechanically act like the parrot-beaked scissors of horticulturalists.

LANGURIA INGENS, n. sp. (Plate XIV. figs. 4 & 5.)

Elongata, supra ænea seu æneo-virida, nitida; capite thoraceque undique punctatis; elytris striato-punctatis, interstitiis minute coriaceis, corpore subtus cum pedibus æneo-nigro, segmentis abdominalibus rufis exceptis; antennis sensim ampliatis 8–11 subtransversis. ♂ femoribus anticis subtus obsoleto-serrato-dentatis. Long. 11 mill.

This species is the largest in the genus from Japan, and comes near to *L. pectoralis*. It is easily separated from it by its large size, broader head, colour beneath, and the general contour of the elytra. The anterior angles of the thorax are never pale, but concolorous with the upper surface. Elytra are widest at the humeral angle, and gradually lessen towards the apex: *L. pectoralis* has a more parallel outline, owing to the greater width before the apex. The canthus of the eye at the point nearest the neck thickens, and from above looks like an angulated tubercle, and seems to serve as a protection to the eye during the retractile movements of the head, and is perhaps caused by the friction which then takes place. It is easy to distinguish the sexes in *L. ingens* by the dilatation of the fore tarsi; but in *L. pectoralis* this sexual character is scarcely observable.

The localities of this species are Chiuzenji and Junsai: on perennials within a few yards of the lakes in these places. I took twenty-five specimens.

The type of LANGURIA PECTORALIS, C. Waterh. (fig. 6, ♂), is a female of *L. convexicollis*. In this and *L. ingens* the males have a series of small denticulations on the undersides of the femora; the middle and hind tibiæ are somewhat bent, and at the apex of each is a small well-defined process or tooth (fig. 5) on the inner side. The female has the middle and hind tibiæ simple, and the fore tibiæ are simple in both sexes.

I obtained about fifty specimens: the plain of Fujisan and Junsai are the chief localities.

Languria nigritarsis, C. Waterh., is very closely allied to *L. pectoralis*. The type is a male, with sexual characters as above, and it is still unique in my collection.

Languria Lewisii, Crotch, has the fore femora of the male very clearly denticulate (fig. 8); the middle and hind tibiæ are less so. The fore tibia, viewed from the front with an ordinary glass, appears regularly denticulated; but a detached thigh, under a high power, shows that the denticulations consist of two rows, and that the placement is by no means uniform. The tibiæ of the male have the apical process almost obsolete, and in this particular agree with the two following species.

It is a common species at Kobe and Nikko and in a few places in Higo.

Languria geniculata, *Harold.*

I transcribe for reference the author's diagnosis:—"Supra ænea, subtus rufa, metasterno abdominisque triangulis apicalibus ænescentibus, pedibus rufis, geniculis tarsisque fuscis, antennis sensim dilatatis fusco-rufis, articulis 4, ultimis fuscis. Long. 7 mill."

If I have determined this insect correctly, it comes very near to *L. Lewisii*; but the antennæ have the 7th and 8th joints less transverse. Of forty specimens only three have the legs coloured as Harold describes them, and his description does not give the sexual characters, which are the same as in *L. Lewisii*.

Kobe, Oyama, Kashiwagi are localities for it, and I saw it in great abundance in the forest behind the large temple at Nara in June.

Languria nara, n. sp.

Near Nara I obtained two males and two females of a *Languria*, which measure only $4\frac{1}{2}$ mill. They are very parallel, with humeral angles scarcely prominent; and as there are no intermediate forms in my long series of *L. geniculata*, I give them a provisional name as above. I have several single examples which apparently belong to as many species, but I leave them over until more material is available.

Languria columella, n. sp. (Plate XIV. fig. 9.)

Elongata, perparallela, ænea, nitidissima, prothorace subquadrato; elytris subigneo-cupreis, margine basali juxta scutellum carinato; antennis nigris, brevibus, sensim amplificatis; pedibus piceo-æneis vel partim rufis. Subtus rufo-picea. Long. $7\frac{1}{2}$ mill.

This very distinct species is sculptured like *L. Lewisii*, and probably belongs to the same section of the genus. At present I have only two examples, and these are apparently both females. The thorax is very parallel, and the same width in front as behind; the humeral angles are scarcely prominent, and much less so than in any other Japanese species. The antennæ are also shorter and more robust in proportion to their length: this is a well-marked character.

I obtained the specimens on 8th May, 1881, in the Government forests, at a considerable elevation above Hitoyoshi. This and the four preceding species sit on the leaves of perennials as described.

LANGURIA FUCOSA, n. sp. (Plate XIV. figs. 12–13.)

Elongata, subparallela; capite nigro; thorace rufo, margine anteriore in medio nigricante; elytris punctato-striatis, cyaneis; pedibus rufis, geniculis piceo-nigris; antennis articulis 1–3 rufis, 4 picea, 5–11 nigris, 7–11 evidenter transversis. Long. 5 ad 6 mill.

This species is very near *L. ruficeps* (figs. 10 & 11), but the head is pitchy black or black, the knee-joints are dark-coloured, and the 7th and 8th joints of the antennæ are clearly transverse, forming apparently a 4-jointed instead of a 3-jointed club. In a long series the larger size is very perceptible. Sometimes examples are red beneath, sometimes pitchy red, and in others the dark anterior margin of the thorax extends and forms a discoid spot.

I took this species at Nagasaki, Kawasaki, Fukui, and Kashiwagi, and it is by no means rare.

Languria prætermissa, Janson, is a very distinct species, and very local. I obtained only two in 1881, from the same glen, behind the temple on Maiyasan, from where the type example came. These measure fully 5 mill.

Mr. Crotch formerly considered that specimens I have from China, resembling *atriceps* and *ruficeps*, were really these species, but they are distinct. If I remember right, his examination of them was only casual.

With reference to the sexual characters mentioned in the preceding descriptions and notes, I may remark that if a male of the *ingens* group is placed over a female as though in the act of attempting coition, it will be seen that the denticulations and roughnesses on the undersides of the femora (fig. 8) scratch the surface of the elytra of the female; the elytra at this part are slightly corrugated, and the attrition thus caused must materially assist the movements of the male. The bent tibiæ with apical teeth (fig. 5) also aid the male at this time, when the legs would be in active motion backwards and forwards, and help to support it while gaining the necessary position. This is seen in two specimens I have gummed the one over the other; and we can also see from these specimens that were these modifications extended to the fore tibiæ, which are always simple, the structure would be of no practical value.

It is a matter of great significance to me that the parts in the appendages of the male most used—parts which in an inorganic substance would be most worn—are the parts where additional tissue centres and forms additional structures, because it is a striking instance of the uniform action of nature, creating in the tibiæ of the Languriidæ parallel modifications to the enlarged muscles of the blacksmith, or the armature of the *Coprophaga* and other insects. The *Copris*, in boring its holes, would wear away its horn, if the increment of tissue did not tend to enlarge and build up that part. If it is said that any individual modification in the parent during, or close on, the act of congress would influence the offspring but little, as the elements of the future animal must then be in a state when modification is almost impossible, still, I think, that little is enough to be a great factor in time. And I would call to mind the fact that in all insects the time of sexual excitement is the time of the greatest physical effort and bodily exertion, and that even in the shortest-lived animals these efforts are continually made without affecting the female, as when possession is attempted by two males. This exercise is also observed sometimes (when the female is absent) between two males. We may be sure that it is when an insect is most active that modification of parts proceeds most rapidly, rather than in the passive time of hybernation or in the quietude of rest; for inert animals, such as Starfish, which live in water of considerable depth, where the temperature and general environment remain for long periods without change, can be traced, almost in their present form, back into geological times. Any modification, too, arising during hybernation would be more likely to be a chemical than a physiological change, and we could not conceive any reason for such modifications which might thus arise being useful to, or in accordance with, the habits of the species.

In all the species of the *ingens* section there is another notable sexual character—the thorax in the male is of much greater convexity than in the female. This development appears to be such as Dr. Leuthner has noticed in certain Lucanidæ, for the purpose of providing the necessary space for storing the muscles, which have enlarged gradually from the energy of the fore legs during the exercise of the functions I have referred to. In *Doubledaya* the thorax has a longitudinal furrow down its centre; and it is therefore probable that the muscles of the legs only occupy the spaces on each side of this groove; or, if the muscles meet in the centre, and form a compact mass, the chitinous covering is drawn down upon them.

In conclusion, let me add a word on the tarsal development of *Doubledaya*, as it appears to be different in some respects to the ordinary sexual dilatation in the Coleoptera. It is in fact only partially sexual. It is in part such as we find in *Carabus* ♂, and part such as we see in both sexes in *Chrysomela*; in the first as being in a degree sexual, in the second as being suited for clinging to foliage. Some of us have seen *Timarcha* on footpaths and herbage in spring and early summer, and noticed the slow drawly movements of the legs. The tibiæ are lifted well off the ground and passed forward in a perpendicular position, then let down, and after that there is another movement. This is a movement of the tarsus by which it becomes firmly attached to the leaf; and this is independent of, and subsequent to, the movement of the legs. This is the action or *use* which, to my mind, gives the breadth to the tarsi of Chrysomelidæ, causing three joints to dilate and absorb tissue at the expense of two others which become obsolete. In *Doubledaya* there is the *Chrysomela*-form of tarsus, existing in both sexes, and an extra breadth in the male, as in *Carabus*. The extra breadth enables the male to cling to the foliage when seated over the female, as specimens placed in this position show; and here also the utility of the shorter legs in the male becomes evident. In *Carabus* there is not this double function in the dilated tarsi, but there is in some of the smaller genera of the Carabidæ. In *Callida* and other foliage-species all the tarsi are fairly ample, and of nearly the same breath. In *Carabus* and *Pterostichus*, where great dilatation is observable, and confined to the fore tarsi, the species copulate in open spaces, and the fore tarsi are then used, as I believe, to arrest the progress of the female, which at this time would be in great activity. But in such genera as *Scarites* and *Morio*, and the innumerable allies of both, which copulate in burrows or under bark, that is in confined recesses from which the female cannot well escape, we see nothing but simple unmodified tarsi.

On these data it seems right to say that the males of *Doubledaya* have tarsi developed on the combined principle of *Carabus* and *Chrysomela*, and that this development is caused by the combination of those influences which act separately in the two last-named genera.

DESCRIPTION OF PLATE XIV.

Fig. 1. *Doubledaya bucculenta*, Lewis, male.
2. —— ——, female.
3. —— ——, male, head, magnified.
4. *Languria ingens*, Lewis, male.
5. —— ——, male, middle tibia, magnified.
6. —— *pectoralis*, C. Waterhouse, male.
7. —— *Lewisii*, Crotch, male.
8. —— ——, male, fore femur, magnified.
9. —— *columella*, Lewis.
10. —— *ruficeps*, Crotch.
11. —— ——, antenna, magnified.
12. —— *fucosa*, Lewis.
13. —— ——, antenna, magnified.

On the Replacement of a true Theca or Wall by Epitheca in some Serial Coralla, and on the Importance of the Structure in the Growth of Incrusting Corals. By Prof. P. Martin Duncan, F.R.S., Vice-Pres. Linn. Soc.

[Read November 15, 1883.]

During the discussions regarding the physiological value of some of the structures of Madreporaria, great discrepancies have been noticed in the opinions of naturalists. Amongst the structures which have been carefully considered, no one has been more debated than the epitheca. It has been pronounced to be worthless in generic diagnosis on account of its not being of primary physiological importance, and not to be of very satisfactory specific value on account of one well-known form having varieties with and without this basal structure. It has been a perplexing structure where it has been found so closely united to a wall of a simple corallum as to render it impossible to determine whether there is a wall at all, and whether the structure is not epithecate entirely. Even in the days when the 'Hist. Nat. des Corall.' was written, the secondary importance of the epitheca in classification was evidently in the thoughts of Milne-Edwards and Jules Haime; and they decided, without the proper examination, that in many instances where there was an epitheca on the base of a compound Aporose coral, it must cover a common plateau or wall.

Really it appears that epitheca may be a simply protective structure covering costæ and the wall, and in the majority of such instances preserving the coral from the attacks of parasites; and that it may also be of great physiological importance, replacing the solid basal theca or wall in compound or colonial coralla, and forming the foundation structure in others, whence the corallites arise and grow upwards.

I have chosen two examples of the importance of epitheca as a fundamental basal structure. A species of *Cœloria* has no true basal wall, but there is a mural epitheca. The mural deficiencies of the species are also noticed between the series. A species of *Leptoria* has also an epithecate basal wall. There is also an example in a species of *Porites* of the method of growth of expanded forms with wide bases, from the upper surface of an epitheca.

These instances, which are types of many others, indicate that it is not reasonable to deny the classificatory value of the epitheca entirely, and that it is of primary importance in many genera.

A species of *Porites* and of *Leptastræa* explain the importance of the basal epitheca on the growth of incrusting corals.

The importance of the epitheca is evident in *Cœloria labyrinthica*, variety *pachychila*, Ehrenberg. This species has been called *Cœloria Forskœlana* by Milne-Edwards and Jules Haime; and it is well described in their Hist. Nat. des Corall. vol. ii. p. 414. They only examined horizontal sections; and they therefore missed the view of the curious internal construction of the coral and the nature of the basal structures.

In the generic diagnosis of *Cœloria*, Milne-Edwards and Jules Haime noticed that the corallum is massive and cellular, very largely fixed by its base, the common plateau being covered with a thin but complete epitheca. The columella is parietal and reduced to a few trabeculæ derived from the inner edge of the septa. In the specific diagnosis they state that the horizontal section shows no columella, and that the union of the corallites is by thin and linear walls.

It is best to examine the walls between the serial corallites first, and then to proceed to the examination of the basal structure. A vertical fracture indicates that there is no true wall between the serial corallites, and the septa are very exsert, standing up far above what, from its position, seems to be the top of a wall. Really this top is the upper surface of a nodule, circular in vertical fracture, which extends from one septum to another in the place of a wall. It is the top nodule of a vertical series standing out from the flanks of opposed septa; and one nodule is separated from those above and below it by some space, where there is no trace of intercorallite wall. This space is occupied by arched dissepiments; so that instead of a solid continuous vertical wall between neighbouring corallites (series), there is a vertical series of nodular processes with endotheca filling up the spaces between them. It is this endotheca which prevents one visceral cavity communicating with those on either side as in the Perforata.

The columella is formed of stout processes from the septal ends, and besides by a growth which commences at the base; it is therefore partly parietal and partly essential, and is always trabeculate.

On examining the base of the corallum, no true theca is found, so the "plateau commun" appears to be a mythical structure. There is a stout epitheca inseparable from any thing else; and it occupies the position of the basal wall, and the septa and columella arise from it. It is very thin but strong, is marked with concentric ridges and lines, as is usual to epitheca; and it clearly bounds the interseptal spaces below.

The nodular processes of the interserial or intercorallite wall cannot be mistaken for synapticula; they are in the line of where a wall might be, and are septal structures. They are, however, very remarkable.

This species certainly departs from the generic characters of the *Cœloriæ*. The well-known mural perforations of *Cœloria dædalæa*, Solander, sp., are close to the margin, and are due to imperfect growth; they in no wise resemble the condition in the form just described. Provisionally the variety *pachychila* must be separated from the *Cœloriæ*; but until further researches are completed, I do not propose to establish a new genus.

LEPTORIA PHRYGIA, *Ellis & Solander, Hist. of Zooph.* pl. 48; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 406.

The specific characters of this form were given by Milne-Edwards and Jules Haime; and the specimen under consideration comes within their diagnosis. In the definition of the genus those authors remark:—"Le plateau inférieur est revêtu d'une épithèque mince mais complète." They of course notice that the series of corallites unite with their neighbours by their walls. According to these descriptions, it is implied that whilst each individual is soldered by its flanks to its neighbours, the whole colony or corallum rests on a common plateau clothed with an epitheca. Presumably there is a theca or basal wall from which the calicular or, rather, serial walls arise.

An examination reveals a different state of things; for on removing the epitheca, which is thin, opaque, and marked with undulating grooves and linear elevations, no trace of a theca, wall, or plateau can be found.

The epitheca covers a considerable surface, and above it, in the lowest position of the corallum, are the lower ends of septa, the interserial walls, and the lamellar columellæ, and all these are united by dissepiments which give a cellular appearance to the whole. In fact, the epitheca is the only basal structure; there is no plateau like a theca; and the upward growth occurred from the thin opaque structure which covered every thing on the stone upon which the coral grew. The epitheca was not adherent in many places to the foreign body. The ridges between the long and rarely sinuous serial corallites are narrow, and septa cross them from one series to those on either side. In the long axis of each ridge is a slender wall which reaches upwards to within a millimetre of the free denticulate septal edge. The septa project at right angles to the wall on either side of it; and on their vertical edge are stout nodular projections, which are recognized on the upper part of the septum where it joins its fellow over the wall as simple dentations. The nodular projections may be seen to unite with corresponding structures on the sides of the slender lamellar columella. This has a thin and lobed free upper edge, and it is seen in the axis of the serial corallites.

The endothecal structures are plentiful, but delicate, arched, and thin. One set of dissepiments stretches from one septum to its neighbour on either side in the same serial corallite, and another set is parallel to the flanks of the columella, and extends from it between the nodular points, and comes in contact with the free vertical edge of the septa. The closing of the inferior parts of the interseptal loculi and of the space between the septa and the columella is perfect; and as the coral grows upwards and outwards, there is a succession of floors of arched dissepiments formed. The columella is essential, and arises from the endothecal base, whence spring the walls and septa.

In this instance the epitheca clearly acts as a base of growth, like the solid theca of some compound corals. Its structure resembles that of the protective epitheca which is seen covering the walls of many simple corals; but it is denser within, and yet is very readily removed by force.

PORITES LUTEA, *Quoy & Gaimard, Voy. de l'Astrolabe, Zooph.* 1833, p. 249.

This species is one of the incrusting forms of *Porites*, or, rather, it has a well-developed epitheca on its large base which covers the substances on which the coral rests, and to which it adheres more or less.

It is a low form; and the specimen under consideration is 4 inches long, 2 inches broad, and 1 inch high in the centre. The edges are thin, and the base is concave, so that the coral is an elongated flat dome in shape. The corallites are about $\frac{3}{4}$ millim. in breadth, and there are therefore a vast number of them in the corallum.

It is perfectly evident that all the corallites could not arise by gemmation from one parent, and that nearly all do arise directly from the base of the corallum.

There is no sclerenchyma made up of a layer of highly trabecular tissue which might act as a base for the corallites to spring from. On the contrary, they arise from the upper surface of the epitheca, which was therefore their basal structure when they commenced growth. Subsequently many did bud on their flanks; but the majority simply grow vertically, or in a slanting direction.

Genus Leptastræa, *Milne-Edwards & Jules Haime.*

This is a genus typical of incrusting and solid Aporose Astræidæ, and the species are very well characterized by their thick intercorallite walls and intercorallite tissue. In a species from Mergui many scores of corallites of 5 or 6 millim. in height covered the uneven surface of a piece of conglomerate; and it is evident that although extracalicular gemmation occurs in a few instances, the majority of the corallites grew side by side from a basal structure, and usually upwards in a vertical line. The base is not a wall, but a very thin epitheca; and there is no true wall.

There is no doubt that this epithecal replacement is very common in the incrusting species of most genera; and the peculiar increase of the corallum is at first by growth from the common epithecate basal expansion and then by gemmation from the wall of the corallite.

On the Auditory Ossicles of *Rhytina Stelleri*. By Alban Doran, F.R.C.S. (Communicated by Professor W. H. Flower, F.R.S., F.L.S.)

[Read December 20, 1883.]

In a recent monograph contributed to this Society and published in its Transactions*, I described the characters of the auditory ossicles of the Mammalia, having succeeded in procuring for the purposes of description and study a very large series of these little bones, which now constitute a special collection, preserved in the Museum of the Royal College of Surgeons of England. It was only with regard to a very few species indeed that I was compelled to rely upon descriptions found in the works of comparative anatomists; for where the vast resources of the College, kindly placed at my disposal by Professor Flower, failed to enlighten me, I generally succeeded in borrowing the desired ossicles from other collections. In describing the ear-bones of the Sirenia, however, I had to rely entirely on description in the case of *Rhytina*, my source of information being a paper by Claudius entitled "Das Gehörorgan von *Rhytina Stelleri*," published in the 'Mémoires de l'Académie des Sciences de St. Pétersbourg,' 1867. Claudius describes the malleus very clearly; but ever since the publication of my own monograph, I have been seeking an oppor-

* "Morphology of the Mammalian Ossicula auditus," Linn. Soc. Trans. 2nd ser. Zoology, vol. i. pp. 371–497, pls. 58–64.

tunity of examining an actual specimen. Through the courtesy of Professor F. A. Smitt, of Stockholm, Superintendent of the Collection of Mammalian Skeletons in the Swedish Department of the recent International Fisheries Exhibition, I have been enabled to examine the malleus of the *Rhytina* obtained in the 'Vega' Expedition. The skeleton in question formed a conspicuous object in the Exhibition. By taking the specimens of mallei of *Halicore* and *Manatus* to the Swedish Department, I had an opportunity of comparing the bones and of making measurements. I have also been able to inspect the right ossicula *in situ* from a specimen kindly lent to Professor Flower by the Commissioners of the United-States Department of the same exhibition.

The malleus in the 'Vega' skeleton only exists on the left side, and is firmly fixed to the tympanic bone by a very stout processus gracilis over 3 centimetres in length. It resembles the malleus of *Manatus* rather than the same bone in *Halicore*. The body, as in the second genus, is very bulky, and well-developed anteriorly and internally; in *Halicore* the body is much smaller, the manubrium forming almost half the bulk of the bone. Bulky, however, as is the body of the malleus in *Rhytina*, the manubrium forms a larger proportion of the entire ossicle than is the case in *Manatus*.

The manubrium in *Rhytina* is, I find, of a different character from the same process in *Manatus*; nor does it resemble that of *Halicore*. In all three genera a groove separates the root of the manubrium, superiorly from the body; this groove is relatively faint in *Rhytina*. In this extinct species the outer border of the manubrium forms a very wide and perfectly regular curve directed outwards. This border is very narrow, though well separated from the sides of the manubrium by sharp edges; the tip is hardly dilated. The inner border is distinctly sharper than the outer: in this point *Rhytina* agrees with *Halicore*; whilst in *Manatus* the corresponding border is exceedingly blunt.

The manubrium in the malleus of the American specimen has been broken off inferiorly, or worn down by the action of water *, and bruised at its upper angle; though that angle with the upper border is still well marked and straight compared to the same border in *Manatus*. The inner border is sharp, and bears a notch produced apparently by injury. The length of the entire manu-

* The plates accompanying Claudius's work (*loc. cit.*) represent a malleus with the manubrium worn down in the same manner.

brium in this specimen from the American skeleton is 1·9 centim., nearly 1 centim. less than in the 'Vega' malleus. In other respects the mallei from the two specimens are very similar.

In my monograph, when describing the manubrium of *Manatus*, I wrote:—"The upper border is very sharp and narrow; it forms a semicircle, and projects against the membrana tympani in the live subject; the outer border is short, and its margins, united above, diverge but little towards the extremity; its surface is concave vertically, and slightly convex horizontally"*.

Careful examination and comparison of the manubrium in all three genera lead me to believe that what I termed the upper border in the manubrium of *Manatus* is in reality only the upper part of the outer border. A small projection where this border joins the body of the malleus above represents a suppressed upper border. What I termed the outer border is, properly speaking, only its spatulate termination, sharply deflected from the superior portion of the same border.

The upper border of the manubrium, then, is obsolete in *Manatus*. In *Halicore* "it is very broad . . . . and sharply bordered from the sides; externally it runs into the outer aspect by forming a prominent bold convexity instead of a processus brevis"†.

In *Rhytina* the upper border of the manubrium is quite distinct, running for nearly half a centimeter from the body of the malleus to the outer border, from which it is separated by a very distinct "processus brevis." This in itself gives the malleus of *Rhytina* a far more generalized character than can be detected either in *Manatus* or in *Halicore*. It is a distinct approach in form to the long scythe-like manubrium of many ruminants.

Returning to the body of the malleus, it appears even bulkier than in *Manatus*. It bulges more posteriorly than forwards, whilst in the Manatee the anterior projection is greater, as the appended measurements will show. The processus gracilis is much stouter than in *Manatus*. The articulated surfaces are very deep, and of the *Manatus* type‡. The incus is as in *Manatus*, the body is equally shallow and wide, and the crura are very divergent. This bone occupies the same position to the malleus as seen in the other Sirenia.

The following measurements will give some idea of the bulk of

* *Loc. cit.* p. 468. † *Loc. cit.* p. 466.

‡ There is no peg-like process below the superior facet, like that which I have seen in *Manatus americanus*, but never found in *M. senegalensis*.

the malleus of *Rhytina*. The 'Vega' specimen, being the more perfect, has been selected for this purpose.

		centim.
Antero-posterior measurement of malleus (root of manubrium to root of processus gracilis)....	Rhytina	1·8
	Manatus	1·8
	Halicore	1·1
Measurement from manubrium to most internal part of body of malleus	Rhytina	2·5
	Manatus	1·8
	Halicore	1·3
Length of manubrium	Rhytina	2·7
	Manatus	1·8 *
	Halicore	1·5

The incus, both in the 'Vega' and the American specimen, is very similar to the same bone in *Manatus*. The body is shallow and wide between the crura. There is not the prominence behind the upper and more posterior of the two lower facets so conspicuous in *Halicore*; so that the posterior part of the body is not larger than in the otherwise much smaller incus of *Halicore*. The upper facet is wider and deeper than in *Manatus*, but, as far as I could judge (not being able to disarticulate the bone from the malleus), of much the same shape. Its dimensions were as follows :—

	Distance betwen extremities of crura.	Depth of body to point of proc. brev.
Rhytina	2·4	1·5
Manatus	1·6	1·2
Halicore	1·6	1·0

(As it is difficult to fix a precise "root" to the processus brevis, the "depth" is taken from the highest part of the body to the extremity —that is, to the point of ankylosis—of that process.)

Lastly, in the American specimen the stapes existed. It fell out of its place in examination, which proved convenient, as will be seen; moreover it was readily replaced. In shape it is very similar to the stapes of *Manatus senegalensis*. The head is equally well developed, and bears an almost circular articular surface 0·5 centim. in diameter (0·4 centim. in *Manatus*). As in *Manatus*, also, both crura are long and hardly divergent; both also are crooked; the anterior, too, is the straighter, and is much thinner in proportion to the posterior than even in *Manatus*. The posterior crus is very bulky, and bulges higher up than in *Manatus*; the thickness of this crus encroaches upon the aperture, which is therefore much smaller proportionately than in the

* The greater curving of the manubrium in this Sirenian, compared with *Rhytina*, must be taken into account, as the extremities are thereby approximated.

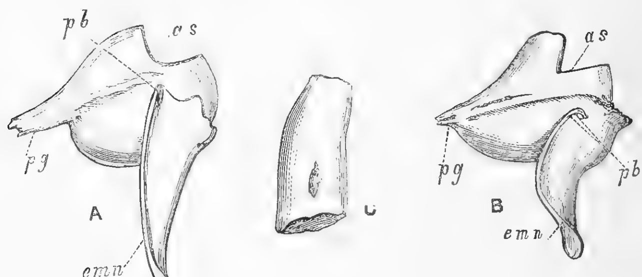
Manatee, and is situated lower down or closer to the foot-plate. This plate is proportionately broader than in *Manatus*; so (as the appended measurements prove) it is as wide as the widest expanse of the crura.

The following measurements (in centimeters) show that *Rhytina* possesses a stapes absolutely larger than that of any other animal. It must be remembered that the ossicula of the Sirenia are bulkier than those of the Cetacea.

	Vertical measurement.	Greatest breadth across crura.	Breadth of foot-plate.
Rhytina	1·9	0·9	0·9
Manatus	1·6	0·8	0·6
Halicore	1·0	0·5	0·6
Balæna mysticetus	1·1	Crura expanded regularly to foot-plate.	0·5
Balænoptera Sibbaldii	1·0		0·7
Elephas indicus	0·6	....	0·4

In conclusion, it may be said that the malleus of *Rhytina* is larger than in *Manatus*; and therefore it is the largest and bulkiest malleus to be found in the whole section of the animal kingdom where such a bone exists; that in the characters of its body it resembles *Manatus* rather than *Halicore*; and that in the manubrium it differs from the other Sirenia, and is far more generalized. The incus is of the *Manatus* type*, and so is the stapes, which is also the largest and bulkiest stapes to be found in any animal.

In the appended drawings I have placed the mallei of *Rhytina* and *Manatus* in the position best adapted for showing the differences in the manubrium.



A. Malleus of *Rhytina Stelleri*. B. Malleus of *Manatus americanus*. Both natural size and outer aspects. C. Stapes of *Rhytina*, natural size. The lettering applies as follows:—*a.s.* articular surface; *p.b.* processus brevis; *p.g.* processus gracilis; *e.m.n.* external surface of manubrium.

* The body of this bone is bulkier in *Macrorhinus* than in *Rhytina*; but the crura are slender as in other allied Seals. Hence *Rhytina* exceeds every living animal in the size of all its ossicula.

The *Hypopus* Question, or the Life-History of certain *Acarina*. By A. D. Michael, F.L.S., F.R.M.S.

(Read January 17, 1884.)

[Plate XV.]

The *Acarina* are so little known in this country, that it is necessary to commence by stating what a *Hypopus* is, and what are the questions concerning it.

In 1735 de Geer* noticed, for the first time, on the House-fly (*Musca domestica*) a tiny red mite, with an oval body enclosed in a chitinous carapace; and having, in lieu of any ordinary mouth, a minute membranous tube, apparently closed, but furnished with two setæ. The two anterior pairs of legs were thick and well-developed, but the fourth pair terminated in long setæ instead of any claw or sucker, resembling in this those of the Itch-mite (*Sarcoptes scabiei*).

Linnæus† adopted the description of de Geer, and called the creature *Acarus muscarum*.

Geoffroy‡ also found what may be presumed to be the same thing; he called it "the brown fly-mite."

Hermann§, in 1757, found upon the ventral surface and legs of a *Scarabæus* larva and the larva of *Osmoderma eremita*, a large number of small red-brown mites, with short legs and spines to the tarsi; these he called *Acarus spinitarsus*. His figure, looked at by the light of our present, somewhat wider, knowledge, leaves no doubt of the analogy between this and de Geer's species.

Schrank‖ in 1781 gave a description of a small mite which he found upon a male *Gamasus* (his *Acarus crassipes*), and which he called *Acarus acarorum*. This, again, is evidently an allied creature.

Dugès¶ in 1834 found, on a *Hister*, a minute mite which he regarded as being identical with Hermann's *Acarus spinitarsus*. He created the genus *Hypopus* for it, and he included in the same genus de Geer's *Acarus muscarum* and also Lyonnet's *pou*

* De Geer, vol. viii. p. 115, pl. vii. figs. 1, 2, 3.

† 'Systema Naturæ.'

‡ 'Histoire des Insectes,' t. ii. p. 624. no. 6.

§ 'Mémoire Aptérologique' (Strasbourg, 1804), p. 87, pl. vi. fig. 5.

‖ 'Enumeratio insectorum Austriæ' (Augustæ Vindelicorum), p. 524.

¶ Ann. Sci. Nat. 2e sér. t. i. p. 37.

de limaçon. He noticed the singular mouth with two setæ; and, in his list of genera, he put a query whether it was a larva.

Dufour*, in 1839, added two species to Dugès's genus; one he found living in closely packed groups on the head and thorax of Coleoptera of the genus *Feronia*, and these he called *Hypopus feroniarum*; the other he found upon Diptera of the genus *Sapromysa*, and called *Hypopus sapromysarum*. He evidently regarded them as specially parasitic upon the particular creature upon which he found them; he also instituted a new genus (*Trichodactylus*) for an allied Acarid which he found parasitic upon bees of the genus *Osmia*.

C. L. Koch†, in 1843, admits the genus *Hypopus*; but in his great work he only gives one species, although, in his later work, he transfers others to the genus, one of which clearly does not belong to it. He also originated a third genus (*Homopus*) for two creatures which he found upon field-mice and squirrels, and which he at first classed among *Dermaleichi*, but which do not appear to differ materially from Dufour's *Trichodactylus*.

Dujardin‡, also in 1843, found on the wing of a bee a small mite for which he originated a new genus (*Anœtus*); this genus he subsequently suppressed, finding it to be simply a *Hypopus*.

Gervais§ next described a new species of *Hypopus*, which genus, oddly enough, he joined to *Tyroglyphus*, without having an idea of the connexion subsequently ascertained to exist, and notwithstanding the great apparent difference. It must be confessed that he also joined to it other genera which have not any connexion with it.

Dujardin‖ returned to the subject in 1847–1849; he then made an elaborate study of *Hypopus*, and it struck him that all the creatures mentioned above were immature forms and not species at all; it was the first time that this idea was put forward, except Dugès's query above mentioned. Dujardin called attention to the numerous ventral suckers which served the *Hypopi* as means of attaching themselves to other creatures on which

* Ann. Sci. Nat. 2e sér. t. xi. p. 278.

† 'Deutschlands Crustaceen, Myriapoden und Arachniden': Regensburg. (In Panzer's German Insects.) 'Uebersicht des Arachnidensystems': Nürnberg, 1839–43.

‡ Ann. Sci. Nat. 3e sér. Zool. t. ii. p. 245.

§ 'Suites à Buffon': Aptères, t. iii. p. 280.

‖ Ann. Sci. Nat. 3e sér. Zool. t. xii. pp. 243–250.

they were parasitic; he observed the absence of mandibles, and, as he considered, of any mouth whatever, and of any reproductive organs or anus. He observed that some *Hypopi*, immediately before the ecdysis, contained within their skin, and completely filling it, an *Acarus* different from themselves, and possessed of chelate mandibles and palpi; finding them in company with Gamasids, and in places where Gamasids were found, he came to the conclusion that *Hypopus* was a young form of *Gamasus*.

Fürstenberg, in 1861*, in his work on the Sarcoptidæ of Mammals, figures and describes an Acarid, which he considered as belonging to Koch's genus *Homopus*, and which Gwilt had found in immense numbers on the skin of a recently-stuffed elephant, for which, not very sufficient, reason he calls it *Homopus elephantis*. It is not quite clear why Fürstenberg deals with it at all, as he expressly says that, although a parasite, it is not an Itch-mite; probably it was because Gerlach held a different opinion and called it "*Symbiotes elephantis*;" but, having dealt with it, Fürstenberg gave a very different description of its mouth-organs from what other writers had given for *Hypopus*; he described maxillæ divided into two equal parts and placed between three-jointed palpi. Fürstenberg carried his measurements to the 4th place of decimals of a millimeter.

Claparède† was the next contributor to the literature of *Hypopus*, in the year 1868; he may certainly have the credit of first connecting *Hypopus* in an intelligent manner with *Tyroglyphus*, although Gervais had classed them together. Claparède found, on hyacinth-bulbs, &c., what he considered to be a new species of *Tyroglyphus*. He had it in great profusion, kept up his observations for three years, and bred large numbers of the creatures, which he called *Tyroglyphus Dujardinii*; but he never found a male, all the specimens he noticed were females. He did not find any Gamasids, but he did find great quantities of *Hypopi*, and moreover he actually saw some nymphs of *Tyroglyphus*, which closely resemble the adult, cast the skin and produce, not a perfect *Tyroglyphus*, as the other nymphs of the same species did, but a *Hypopus*. He never could see any eggs in a *Hypopus*. Claparède's observations were absolutely correct, but the deduction which he drew from them was that *Hypopus* was the male of *Tyroglyphus*. Claparède took the opportunity of attacking

* 'Die Krätzmilben von Menschen und Thieren' (Leipzig, 1861), p. 208.

† "Studien an Acariden," Zeitschr. wiss. Zool. 18 Band, p. 445.

Fürstenberg's *Homopus*, which he declares to be wrongly described, and to be an ordinary *Hypopus*.

Claparède's suggestion that *Hypopus* was the male of *Tyroglyphus* was practically disproved before he made it, for, while Claparède was studying this *Tyroglyphus*, he was not aware that Professor C. Robin and Dr. Fumose were doing the same thing; they published their paper* shortly before Claparède's. They called the species *T. echinopsis*, which name must stand. They did not deal with *Hypopus*, which they apparently did not trace as being connected with the life-history, but they did find the unquestionable male of the species.

P. Mégnin took up the subject in 1873, first in his memoir upon *Tyroglyphus rostro-serratus*†, and afterwards in his memoir on *Hypopus*‡; and his labours were rewarded by the French Académie des Sciences with the Thoré Prize of 1873. His may be said to be the present theory.

Mégnin experimented upon *Tyroglyphus rostro-serratus* and *T. mycophagus*, both of them species found by him in immense quantities on mushrooms (*Agaricus campestris*); he bred his creatures in cases, supplying them with pieces of fresh mushroom from time to time. He found that when the mushrooms and cages got dry, his *Tyroglyphi* disappeared, and were replaced by swarms of *Hypopi*; when moisture was added, the *Hypopi* disappeared, and the *Tyroglyphi* were again in great quantities. Specimens which he kept in separate cells appeared to be almost inert, and adhered motionless to the side of the cell, but when moisture was added, these *Hypopi* turned into nymphs of *Tyroglyphus*. The construction which Mégnin put upon these facts is, that *Hypopus* is a form into which nymphs of *Tyroglyphus* change, when, through dryness of the atmosphere, or other causes, there is a difficulty in their continuing to live as *Tyroglyphi*, and that it is a provision of nature to insure the preservation of the species, by carrying it over periods of drought, &c.; he also saw the *Hypopus* inside the nymph of *Tyroglyphus* just before the ecdysis, as Claparède had done.

Mégnin also attacks Fürstenberg—declares that the latter's mouth-organs were pure fancy, and speaks very strongly against

* Journ. de l'Anat. et de la Physiol. (Robin's), 1868, No. 3 (May and June).

† Comptes Rendus Acad. Sc. Nat. 1873, 2e sér. pp. 129 and 492; Journ. de l'Anat. et de la Physiol. (Robin's), t. ix. p. 369 (1873).

‡ Ibid. t. x. p. 226 (1874).

such exercises of imagination. He regards *Hypopus*, *Homopus*, and *Trichodactylus* as being all similar things, and as having the power of remaining without any nourishment during the whole period of their existence in this stage, and this view he supports in a special paper on the subject*.

In a subsequent memoir†, Mégnin extends his view of the nymphs of certain *Acarina* assuming a hypopial condition in order to preserve the species under adverse circumstances, so as to include the case of certain *Acari* found in the cellular tissue of birds by Giuseppe Gené‡, Charles Robertson§, Montagu‖, and Filippo de Filippi¶, which the last-named writer called *Hypodectes*, but which Mégnin considers to be the hypopial nymphs of feather-feeding Sarcoptidæ (*Pterolichus falciger*).

In one of his latest works** Mégnin states that Dufour's *Hypopus feroniarum* is the hypopial nymph of *Tyroglyphus rostro-serratus* (*Serrator amphibius*), Mégnin, and that the *Acarus spinitarsus* of Hermann is the same as *Homopus elephantis*, Fürstenberg, and is the hypopial nymph of the common Cheese-Mite (*Tyroglyphus siro*). He does not say how the last fact was ascertained; and in his memoir on *Hypopus*, above quoted, he states Hermann's *spinitarsus* to be the hypopial nymph of his *Tyroglyphus mycophagus*.

Mr. Tatem††, in 1872, figured and described, under the name of *Acarellus muscæ*, a creature which is a *Hypopus*, and which he is of opinion that he took from the abdominal cavity of a dead flea.

Andrew Murray‡‡, in November 1876, entered vigorously into the dispute. He does not seem to have made any personal observations, but he elaborately discusses almost all the above-

* "Mém. sur les Hypopes," Journ. de l'Anat. et de la Physiol. (Robin's), t. x. p. 225 (1874).

† "Les Acariens parasites du tissu cellulaire, &c., des Oiseaux," ibid. t. xv. p. 120 (1879).

‡ 'Brevi cenni su un Acaridio del genere dei Sarcopti che vive sulla *Strix flammea*:' Torino, 1848.

§ Microscopical Journal, Feb. 1866.

‖ Mem. Wernerian Nat. Hist. Soc. 1808, vol. i. p. 176.

¶ "Note zoologiche 1. *Hypodectes* nuovo genere di Acaridi," in Archiv per la Zool., l' Anat. e la Fisiol. fasc. i. pp. 54–60: Genova, 1861.

** 'Les parasites et les maladies parasitaires': Paris, 1880.

†† Monthly Microsc. Journ. 1872, p. 263, pl. xl.

‡‡ 'Economic Entomology, Aptera': London, 1877.

named authorities, and finally comes to a totally new conclusion, viz., that *Hypopus* is a ferocious predatory parasite, and that it eats its way into the body of its victim, and then devours its whole internal parts, only leaving the skin. He quotes the example of *Rhipiphorus paradoxus*, to show that a creature may be an external parasite at one period of its life, and an internal one at another.

Notwithstanding Mégnin's exposition, some acarologists of eminence continued to consider *Hypopus* as a separate adult creature, and continued to frame new species and genera for newly discovered hypopial forms. Profs. G. Canestrini and E. F. Fanzago's *Chironemus**—afterwards changed to *Tarsonemus*†, because the former word had been already employed for a genus of fishes—consists of *Hypopi*. Dr. P. Kramer's female *Dendroptus*‡ appears to be the same thing. Canestrini and Fanzago also preserve Dufour's genus *Trichodactylus*§. The *Labidophorus talpæ* of Kramer also appears to be a hypopial form‖. In the last-named paper Kramer also described another very singular parasite of the Mole, which he called *Pygmephorus spinosus*, which has an immensely developed monodactyle claw to the front leg, and somewhat rudimentary mouth-organs ; he described the male only. R. Canestrini subsequently added a new species, *mesembrinæ*¶, to Kramer's genus *Pygmephorus*.

G. Haller, in 1880, published a paper** upon Acarina parasitic upon Invertebrata, in which is a summary of existing writings on the subject, and in which, although he does not record any special observations of his own upon the point, he suggests that the hypopial form is a "travelling-dress" for *Tyroglyphus*, to enable it to endure the journey from one fungus, &c., to another, which would sooner or later be rendered necessary by the drying or destruction of the fungus.

* "Nuovi acari Italiani," Atti Soc. Veneto-Trentina di Sci. Nat. vol. v. fasc. i.

† "Nuovi acari Italiani," ser. 2, ibid.

‡ "Ueber *Dendroptus*," Archiv für Naturg. xlii. Jahrg. (1876), p. 198.

§ "Intorno agli acari Italiani," Atti R. Ist. Veneto di sci., lett. ed arti, ser. 5, vol. iv. p. 137.

‖ "Zwei parasitische Milben des Maulwurfs," Archiv für Naturg. xliii. Jahrg. (1877), p. 248.

¶ "Contribuzione allo studio degli acari parassiti degli insetti," Atti Soc. Ven.-Trent. di Sci. Nat. vol. vii. fasc. ii. (1881).

** 'Die Milben als Parasiten der Wirbellosen :' Halle, 1880.

Finally, in 1881, A. Berlese published a paper* in which he in the main agreed with Mégnin, but went somewhat further, asserting that Kramer's *Pygmephorus* was not an adult form, that *Hypopus* took no nourishment, and was entirely without buccal or anal apertures, that its labium was a tactile organ, and that all *Acarina* which had rudimentary mouth-organs, and were without buccal and anal openings, were hypopial forms. This paper is complicated by the author's exceptional views as to polymorphism, &c.

These are the principal records; but Mr. J. S. Macintyre informed me that he also has seen *Tyroglyphi* turn into *Hypopi*, although I am not aware that he has published his observations.

I have not attempted an exhaustive abstract of any of the above-named papers, many of which are lengthy, but have simply sought to set out, in as few words as possible, such parts as are essential to an understanding of the aim and results of my own observations; and also, to some extent, to draw attention to what has been done by others. To summarize the literature, eight different suggestions are before the public as to what a *Hypopus* really is; these are made by the writers whose names are set opposite to the respective explanations, viz.:—

1. *Hypopus* is a separate family of adult *Acarina* ...	Writers before Dugès; also Koch, Dufour, and some present authors.
2. *Hypopus* is an immature stage of *Gamasus*	Dujardin.
3. *Hypopus* is an itch-mite	Gerlach.
4. *Hypopus* is the adult of both sexes of some species of *Tyroglyphus*	Gervais.
5. *Hypopus* is the male of *Tyroglyphus*	Claparède.
6. *Hypopus* is the "cuirassed heteromorphous *adventitious* nymph of *Tyroglyphus*," &c., appearing only for the distribution and preservation of the species under adverse circumstances	Mégnin, Berlese, &c.
7. *Hypopus* is a ferocious parasite, sometimes external, sometimes internal, which ends by entirely devouring its host from within, leaving only the skin	Andrew Murray.
8. Hypopial form is a travelling dress	Haller.

It is the correctness or error of these diverse opinions that I

* "Indagini sulle Metamorfosi di alcuni acari insetticoli," Atti R. Ist. Veneto di sci., lett. ed arti, ser. 5, vol. viii.

have endeavoured to ascertain; but first let me say a few words as to what a *Hypopus* is like.

There are several forms of *Hypopus*, differing more or less from each other, but to take a typical kind, such as Dufour's *feroniarum*, it is an extremely minute Acarid, rarely more than ·25 millim. in extreme length, which presents, at first sight, somewhat the appearance of a miniature *Limulus* without a telson, its whole dorsal aspect being entirely covered by a nearly hemispherical, chitinous carapace, concealing cephalothorax and abdomen, and coming to the ground all round when the creature is quiet. The two front pairs of legs and the long setæ at the ends of the fourth pair project somewhat when the animal is walking, but can be entirely withdrawn under the carapace, and usually are so. The mouth-organs are very rudimentary, consisting, it is asserted, of a mere hole, covered and closed by a flap, and from which projects a tube of moderate length, getting finer towards the distal end, where it is said to be closed, and which tube terminates in two long bristles, which do not pass within the tube, and cannot, it is said, be regarded as maxillæ. The ventral surface is covered with a soft integument, and bears numerous suckers, chiefly near the posterior part; by these suckers the creature adheres to the polished, chitinous surfaces of Insects, Gamasids, &c.

The three front pairs of legs terminate in a double claw, and caruncle or sucker; the fourth is without either, and terminates in very long bristles, like the hind legs of *Sarcoptes scabiei*, but larger in proportion; this is probably what deceived Gerlach, and led him to consider it an Itch-mite. The chitinous carapace is frequently sufficiently transparent to allow the form of the creature to be seen through it.

For some two or three years I had carefully watched *Tyroglyphi* in confinement in small glass cages, under favourable and unfavourable conditions, but my efforts were chiefly directed to *Tyroglyphus siro* and *longior*, and I did not succeed in getting any hypopial forms from them, nor in seeing any thing that would elucidate the question. In 1881, however, I came across a quantity of Mégnin's *Tyroglyphus mycophagus*; I soon found that, with this species, there was not any difficulty whatever in repeating his experiments. The nymphs readily turned into *Hypopi*, and the *Hypopi* returned to the form of nymphs of the *Tyroglyphus*, in each case by an ecdysis; and I was able to secure and preserve microscopical slides, mounted during the progress of the change, and showing the *Hypopus* forming, or formed, inside the *Tyroglyphus* nymph, which I still possess. This appears to be sufficient to answer Andrew Murray's view that *Hypopus* is an internal parasite; because, firstly, the *Hypopus* is very nearly as large as the *Tyroglyphus* from which it emerges, filling up the whole interior, which seems highly improbable with a creature which cannot grow inside; for *we never see young Hypopi* smaller than their fellows either within the *Tyroglyphus* or living free. All the *Hypopi* of the same sort which are found are about the same size. Secondly, we never, by any chance, see a *Hypopus* within the larva or within the adult, only within the nymph; although the difference between larva, nymph, and adult in *Tyroglyphus* is very slight. Thirdly, we never see two *Hypopi* within the same *Tyroglyphus*, although, when the *Hypopus* has emerged, we often find numbers ectoparasitic upon the same *Gamasus*, insect, &c. Fourthly, the emerging of the *Hypopi* is preceded by an inert period, just as the ecdysis is in most *Acarina*. Fifthly, the *Hypopus*, when it emerges after the ecdysis, leaves behind it the cast skin quite clean, and without any torn particles of internal organs adhering to it; in fact, in the ordinary state of the exuvia of Acarina and insects. Sixthly, the mouth-organs of *Hypopus* are not in any way fitted to consume the solid tissues of its host. Seventhly, the *Hypopus* returns to the *Tyroglyphus*-form after the next ecdysis.

If these considerations dispose of Andrew Murray's suggestion, as I think they do, they also dispose of the view that *Hypopus* is a distinct creature; for that could now only be sustained if Murray's view were received; otherwise the evidence of Claparède, Mégnin, Berlese, Macintyre, and myself, who have all actually seen the change, would probably be accepted as sufficient to prove that the form is a stage in the life-history of *Tyroglyphus*.

Claparède's view, that *Hypopus* is the adult male, was practically answered by Robin and Fumose; and it will, I think, be found below that it is even more effectually disposed of by my own observations in 1882, which would also answer Gervais's idea. There therefore only remain Mégnin's and Haller's explanations. My observations decidedly confirmed Mégnin's view, that the true *Hypopus* is a heteromorphous nymphal form of *Tyroglyphus*, and possibly of some allied, or other, genera.

It remained to be seen whether I should be able to verify his conclusions as to the causes of the transformation. For this purpose I allowed the cell to get dry, but I did not thereby obtain any increase in the number of *Hypopi*; although I did find a very great diminution in the number of *Tyroglyphi*, which died off, as the moisture became insufficient, until they disappeared altogether. Upon redamping the cell more larvæ and young nymphs soon made their appearance from the eggs which the previous adults had laid, and older nymphs from the *Hypopi* were found undergoing ecdysis; but this occurred gradually, not all at once: the *Hypopi* did not vanish suddenly, nor were fresh adults to be found until they had grown. It must be remembered that I did not introduce fresh fungus into my cells as Mégnin did.

This experiment of allowing the cells to dry, or partially dry, was repeated several times, but always, practically, with the same results. It would seem, therefore, that desiccation or other unfavourable circumstances, will not necessarily cause *Tyroglyphus* nymphs to change into *Hypopi* more rapidly than they would otherwise have done.

In the spring of 1882 I resumed the subject. I was staying at a farm-house where they had an old-fashioned chaff-house adjoining the stable: this was not kept in the well-swept condition usual in modern stables, but the chaff and *débris* of the fodder were allowed to remain in a pile on the brick floor, which was always rather damp, and altogether the conditions were as favourable to *Tyroglyphus* life as can well be imagined—warmth, moisture, and abundant food were there, and, consequently, the chaff was teeming with life; *Tyroglyphi* were swarming, Gamasids were there in quantities preying upon them, and minute Diptera and their larvæ, Myriapoda, &c., were abundant; but *Hypopi also were in great profusion*, and continued to be so, and to attach themselves to every living insect or Gamasid which came into the chaff. It was evident, therefore, that the most favourable circumstances did not prevent the *Tyroglyphus* becoming a *Hypopus*. The principal species of *Tyroglyphus* were *T. farinæ*, *T. mycophagus*, and Mégnin's *T. rostro-serratus* (subsequently called *Serrator amphibius* by him, *Phyllostoma pectineum* by Kramer*, and *Histiostoma pectineum* by Canestrini and Berlese†).

* "Beiträge zur Naturgeschichte der Milben," Archiv für Naturgesch. xlii. Jahrg. 1876, p. 39.

† "Nuovi acari," Atti Soc. Ven.-Trent di Sci. nat., vol. viii. 1881.

The hot-bed for cucumbers at the same place, which was made up from the stable-manure, and which presented equally favourable conditions, swarmed with *Hypopi*, which covered every small dipterous insect that emerged from the hot-bed.

I now endeavoured again to try the converse experiment. I collected a number of *Tyroglyphi* and placed them in two kinds of glass cells, viz.:—1, the small cells which I use for breeding Oribatidæ, which are covered up by a glass plate, and in each of which I only put one or two specimens, so that I can watch and know each individual; 2, the other, the larger cells (small dissecting troughs), which I use for breeding Gamasidæ, where the cover is pierced with a few small holes, with muslin over them, so placed that they can be made to communicate with the interior of the cell or not as desired, by moving the cover: in these cells a number of specimens can be placed if it be wished. I now tried similar cells, each with a number of Tyroglyphidæ, and, when they were breeding freely, allowed one cell to get dry and kept the other in proper hygrometric condition. I did not find that I got more *Hypopi* in the cell that dried than the other; on the contrary, I got more *Hypopi* where breeding was under favourable circumstances, and, consequently *young* nymphs more abundant; but I did find that as the cell dried the Tyroglyphidæ retired into any hole or shelter which afforded a prospect of retaining moisture. Thus I kept a small piece of blotting-paper in the cell in order to damp when more moisture was required, for actual water must not be put in in drops on the glass, or the Acari will drown. As the cell dried, I sometimes found that the *Tyroglyphi* all got under the blotting-paper, and I could not see one of them; but if the drying process were stopped short of what would destroy life, and fresh moisture added, they soon came out again; if fresh moisture were not added they died, and were not seen again. The *Hypopi* endured drought better, but if it were continued, they died also. I repeated these experiments several times, but always with the same result. This may possibly account for the way in which Mégnin's *Tyroglyphi* disappeared and *Hypopi* appeared when the cell got dry, and the former reappeared on adding fresh fungus, in his glass cages containing strips of fungus. However that may be, I did not succeed in producing or hastening the change to *Hypopus* by drying, either in the larger cells, or in the smaller where I could watch the individual *Acarus*.

At this time *Hypopi* were numerous in moss in the neighbourhood. In April (1882) I took two similar specimens from moss, and placed them alone in a small glass cell with blotting-paper. In a few days they became inert, and one changed into a *Tyroglyphus* nymph, leaving its exuvium on the blotting-paper. The other soon afterwards did the same. Early in May one of the nymphs underwent ecdysis, and became an adult *Tyroglyphus*; about the 13th of May the second became inert, and shortly afterwards changed to an adult *Tyroglyphus*.

One thing that became evident in breeding the *Tyroglyphi* and *Hypopi* was that the full-grown nymphs of the former did not change into the latter, but that it was the young nymphs that changed, and that the change occurred always at the same stage of the life-history. It appeared to me, with those species which I have observed, that the change occurred at the second nymphal ecdysis, and the hypopial form continued until the following ecdysis: this probably accounts for the small size of the *Hypopus* compared with the adult *Tyroglyphus*.

I found, by carefully watching individual specimens, that they do not all turn into *Hypopi* during the course of their life-history, but, on the contrary, most proceed from larva to nymph, and through all the nymphal ecdyses, and become adult, without assuming a hypopial condition; but that, whatever be the conditions under which they are kept, *Hypopi* will keep appearing if the species be one where the *Hypopus* is easy to breed, and if young nymphs be present.

Another matter which I was careful to watch, was whether both sexes or only one assumed the hypopial form, as it might be possible that, although Claparède was wrong about their being adult males, they still might be a form confined to one sex. I therefore watched this in cells into which I had put several *Hypopi*, but not any other Acarina nor ova. I found that the *Tyroglyphi* which emerged from the hypopial skins were of both sexes; the female predominated, but not more than it usually does in *Acarina*.

What, then, is the reason of this hypopial stage? It seems to me that it is simply to facilitate the distribution of the species, so that the *Acarus* may lay hold of any small living object that comes within its reach, and be carried to "fresh fields and pastures new," which it could not otherwise reach. It is manifest that, being carried by such creatures as bees, flies, &c., which delight in hot sunshine, a thing which kills most *Acari*, the hypopial condition, which enables this creature to endure greater heat and absence of moisture than the ordinary *Tyroglyphus*-form can survive, must be of advantage to it.

It may be worth consideration whether the travelling of *Hypopi* may not be the explanation of Tyroglyphidæ appearing suddenly in places where they have not appeared before, and where their presence is not desired or its cause understood, a matter very troublesome occasionally in a household. A fly or a bee would not be suspected, and may convey a few small, almost invisible *Hypopi*, which would soon become adult, and then multiply with great rapidity. Another instance may be the frequent appearance of mites (*Tyroglyphus entomologicus*) in collections of insects; two or three specimens, if they became adult, would soon produce a quantity of *Tyroglyphi*, which would greatly injure the entomological preparations, and these two or three specimens might often be adhering to the insects in the collection when introduced, and pass unnoticed, being concealed by hairs &c. *Hypopi* often remain a long time in that condition; I have had them over three months.

It now remains to consider Dufour's *Trichodactylus*. It has been mentioned above that, n 1839, this naturalist instituted a genus, thus named, for a creature resembling *Hypopus*, which he found on bees of the genus *Osmia*. Dufour's figure and description show the regular *Hypopus* rostrum and the first three pairs of legs, similar to each other, somewhat long, of nearly equal thickness throughout, and terminated by a long, slightly curved, double claw. The fourth pair of legs are clawless, and terminate in long setæ in the true *Hypopus* fashion. Dufour's figure and description are rather slight.

In 1875 Prof. A. L. Donnadieu published * an elaborate and careful treatise upon this species (as he considered) and on an Acarid found by him upon *Xylocopa violacea*, which he names *Trichodactylus Xylocopiæ*. These creatures have the fourth leg terminated by one or three very long setæ, according to species, in the *Hypopus* manner, like Dufour's *Trichodactylus*. In Donnadieu's specimens, however, the first leg is much thicker than the others, and is terminated by a very large and remarkable *single* claw, apparently formed for holding hairs, and greatly resembling

* "Recherches anatomique et zoologique sur le genre Trichodactyle," Ann. Sci. Nat. 5e sér. Zool. t. x. pp. 69–85.

the claw of *Pediculus capitis.* The second and third legs are also terminated by single claws, but less remarkable in size and form. Donnadieu says that Dufour has confounded the two species, and that, probably from the imperfection of his instruments, he has misdescribed the creatures in many respects, and in particular as to the legs, where, in addition to other errors, he has described double claws instead of single. Donnadieu's Acarids had a soft closely-wrinkled skin resembling *Sarcoptes*, to which genus he considers *Trichodactylus* to be allied, although it is not subcutaneous. Donnadieu describes both sexes, and gives details of the reproductive organs and of the mode of copulation: he describes the maxillæ, mandibles, lingua, &c., and gives excellent drawings of the whole.

Dujardin considered that Dufour's *Trichodactylus* was the same as *Hypopus*, and, in spite of Donnadieu's details, Mégnin, Berlese, and others have maintained that the two so-called genera are identical, and that consequently *Trichodactylus* consists of immature forms, and not of species at all. I am not inclined to offer an opinion as to what Dufour's species is upon the evidence of his paper alone; but I am indebted to the kindness of Prof. Donnadieu for the loan of the only two specimens of his two species which he still possesses, and the examination of them has decidedly led me to the conclusion that they are not *Hypopi*, but are adult creatures, and that, as far as I can judge, Donnadieu is right in considering them to be somewhat allied to *Sarcoptes*. Whether they be identical with Dufour's species seems to me a more doubtful question. I may mention that Donnadieu's species are very much larger than any *Hypopi* which I have ever seen. I did not receive them or come to the conclusion that they were good species, until after I had had the advantage of making the investigations referred to below upon Mr. George's bee-parasites.

In April 1879, Mr. C. F. George, of Kirton Lindsey, published a short account of an Acarid which he found the previous year parasitic upon the Gamasidæ which were infesting the Queen humble-bees, particularly *Bombus virginalis**; he says he "supposes it must be a *Hypopus* (whatever that may be)." The whole of the cephalothorax of this creature, which is far the largest portion of it, is covered by a polished, chitinous carapace, extending greatly

* "On the Mite of the Humble-Bee, *Gamasus*," Science Gossip, vol. xv. pp. 81, 82 (1879).

beyond the body (Pl. XV. figs. 3–4); the abdomen, however, projects behind this carapace, and is decidedly segmented, a most exceptional thing in adult Acarina, although sometimes found in larvæ. The first leg is much enlarged, and is provided with a great, single, holding-claw, exactly like Donnadieu's *Trichodactylus Xylocopiæ*, but, oddly enough, the second and third legs have didactyle claws, like Dufour's figure, which was considered an error. The fourth leg is terminated by long setæ, as in *Hypopus*, *Trichodactylus*, &c.

When this account appeared I, like its discoverer, imagined it to be a *Hypopus*, and I have ever since been desirous of investigating its life-history, greatly with the view of assisting to decide the *Hypopus* question. It was not, however, until the spring of the present year (1883) that I succeeded in obtaining healthy living specimens in sufficient numbers to enable me to carry out the research. This year, however, partly from my own captures of humble-bees, and partly from the supplies of living specimens sent me by that excellent collector Mr. E. Bostock, of Stone, I found myself in a position to pursue the subject.

Mr. George apparently regarded his so-called *Hypopus* as strictly a parasite of the *Gamasus* which lived on the bee, not as a parasite of the bee itself. I, however, soon found, when I had an ample supply of material, that quite as many existed on the bee as on the *Gamasus*: my first hope therefore was that I might keep the bee alive with the whole united-happy-family of *Gamasidæ*, *Hypopi*, &c. I was unfortunately entirely unable to do so under any conditions which would enable me to watch such small creatures as the *Hypopi*; I therefore had to abandon this idea, and limit my ambition to keeping alive such Gamasids as bore *Hypopi*, which I knew that I could do. In the meantime, however, I had found several solitary specimens of the supposed *Hypopus* in moss, where I was searching for Oribatidæ; these were not parasitic upon any thing, and it therefore struck me that possibly the *Hypopi* might live in a cell without any host. tried, and found that they lived very well for a considerable time; and, as hereinafter stated, I ultimately found that, when I had discovered suitable food, they lived quite as well without any host as with one. I did not employ any of the *Hypopi* found in moss for my investigations, for fear of confusion of species, but confined myself strictly to those found on the bee or on the Gamasidæ infesting it.

Having got my creatures to live, the next step was to watch the life-history, and observe what this particular *Hypopus* turned into. I expected to see it turn into *Tyroglyphus*, and I started several cells with living *Hypopi*, the cells being divided into three series, differently treated. In series 1 I put only *Hypopi* which were on the bee itself; in series 2 only Gamasids bearing *Hypopi*; in series 3 both separate *Hypopi* (as in series 1) and Gamasids (as in series 2). I placed my captures under what seemed to me the most favourable circumstances; but, to my annoyance, they obstinately refused to turn into any thing; they lived a considerable time, were tolerably active, but eventually died, and no information was obtained: this was specially true of series 1. As to series 2 I found that the *Hypopi* which I had put in loose soon got on to the Gamasids, occasionally as many as six upon one Gamasid; but in the same series, and in number 3, I also found the converse, viz. that the *Hypopi* gradually left the Gamasids and wandered about loose. I now became afraid that if the *Hypopi* turned into *Tyroglyphi*, or any thing similar, the Gamasids would eat the adults and I should not see them; therefore I gradually removed from some of the cells the Gamasids which no longer bore any *Hypopi*. Another source of difficulty existed with those cells which contained Gamasids: in order to keep these Acarids in health I have found it best to feed them on cheese-mites (*Tyroglyphus siro*), as I do not know any equally suitable living food which can be procured so easily. I thought I should be sure to know *T. siro* from any thing that the *Hypopi* might turn into; but it was possible they might be so alike that I might not distinguish them. Regularly feeding the Gamasids with cheese-mites is rather laborious; so in one cell I tried the effect of putting in a minute scrap of cheese for the cheese-mites to breed in. Coming to examine this cell on 22nd April, 1883, I found, to my surprise, that all the *Hypopi* had left the Gamasids and were grouped together on the cheese. I removed the Gamasids, and then gently lifted some of the *Hypopi* off the cheese. I found below them a number of almost globular, milky-white eggs, which struck me immediately as being different from cheese-mites' eggs. Of course the supposition immediately presented itself that the supposed *Hypopi* were not *Hypopi* at all, but were adult creatures, and had laid these eggs. This, however, required a good deal of confirmation. I removed the eggs and placed them in a separate cell, without any other Acari. I examined this cell on the 28th April, and found that the eggs had mostly hatched, and that the cell contained a number of hexapod larvæ which were unknown to me: all the three legs had didactyle claws. This creature is described below and is figured at Pl. XV. fig. 1. These larvæ grew rapidly, and on the 1st May I found that some had become inert and had swollen up into mere shapeless lumps, as is common with the Acarina before the ecdysis. I expected to see an octopod nymph emerge from this inert creature, but on the following day (May 2nd) two so-called *Hypopi*, exactly like those caught on the bee, emerged from the inert larvæ, and more subsequently emerged. I found, however, that some, when they emerged, were very different from the supposed *Hypopi*, and were not creatures enclosed in a hard carapace any more than the larvæ had been. This puzzled me, as it appeared as if it must be the nymph, and as if I had missed that stage in the other specimens *. From what I subsequently observed, however, the supposed nymphs appear to be the males, although so very different from the females as not to be suspected at first. This male is described below, and figured, Pl. XV. fig. 2.

This creature has the posterior part of the abdomen covered by a brown shield-shaped plate, which makes it very conspicuous amongst the larvæ; it also has the hind legs very thick and peculiar in form, but they are terminated by setæ, not claws nor suckers. It is smaller than the adult female, and even than the larva in its final inert, swollen condition. While I imagined this to be the nymph I put several specimens, in many instances, into separate cells, hoping to see them change into adults. Nothing of the kind, however, took place; they lived for some time, and then died, but without change. In the meantime, however, I began to observe that, among those which had not been separated, one of these supposed nymphs, with the brown abdominal plate, was frequently attached to a white inert larva, the singular hind legs of the nymph grasping the larva, which the nymph dragged about with it wherever it went. At last this became so general that there was hardly an inert larva in the cells that was not in the possession of one of the brown-tailed forms. These facts, taken together, naturally led me to the conclusion that I had probably really got the male, not the nymph; and an examination

* This appeared more probable, as the nymphal stage occurs in almost all other Acarina with which I am acquainted.

with a view of ascertaining this soon led to the discovery of a comparatively large, chitinous organ, below the brown shield-shaped plate, which closely resembles the penis in many species of Sarcoptidæ parasitic on birds, as, for instance, *Proctophyllodes glandarinus*, which are the very creatures where a similarity might be expected to occur. I feel no doubt, therefore, that this is the male; but, from the varying position in which the inert larva is held, I do not look upon the process as actual coition, but rather as a holding possession with a view to coition immediately the adult female should emerge, possibly before the chitinous carapace had time to harden. I do not, in this, rely on the fact of the inert form being immature; as in the above-named case of *P. glandarinus*, and in other members of the Analginæ (Dermaleichi), the male always copulates with a female which has not undergone the last ecdysis nor assumed its final form.

The inert larva, when it is dragged about by the male, generally has the wholly or partly formed adult female showing plainly through the semitransparent larval cuticle.

I had observed that the cheese vanished slowly, even in those cells which did not contain any cheese-mites, and that what I will, for the moment, still call the *Hypopi*, for want of a better name, were very much about it. I therefore afterwards tried it in breeding, and found that they throve well where it was. Utilizing this, I placed some of those which I had just bred from the eggs into a separate cell, and I succeeded in getting them to lay eggs, and in rearing these eggs through their whole life-history, as I had done in the first instance; and this I repeated through several generations, always with the same results, and without the assistance of any bee or *Gamasus*.

I have never seen either the larva or the male upon the bee or the *Gamasus*, only the adult females; this is not altogether exceptional among *Acarina*, as in many Gamasidæ the females and nymphs are parasitic, either temporarily or permanently, although the male never is so.

I think that the above detailed experiments prove that this so-called *Hypopus* of the *Gamasus* of the humble-bee is a separate adult species, fairly forming the type of a distinct genus. I propose to call it "*Disparipes bombi*" *.

* Decidedly the nearest ally is Kramer's *Pygmephorus*: the rostrum, body, and a large portion of the general arrangement is strikingly similar, but the great difference in the fourth pair of legs, the absence in *Pygmephorus* of the chiti-

I believe that it will be found that this is not a single species, but is rather the type of a considerable genus. I have found a number of females closely resembling those of *D. bombi*, but so very much smaller that they can scarcely be the same, as intermediate sizes do not occur. I have also found in moss a very small species which appears to have the adult female, male, and larva, which is dragged about by the male, all having a sufficient similarity to *D. bombi* to justify their being included in the same genus. The adults are usually of a bright green colour, somewhat varied occasionally with yellow and black, the colour being greatly communicated by the food. I hope to describe this more fully on a future occasion, and in the meantime would call it provisionally *Disparipes viridis.* I have also found other creatures which will, I think, have to be allotted to the same genus.

To summarize the results of my observations, it appears to me :—

1. That true *Hypopi* are not adult animals, but are a stage in a life-history.

2. That they are heteromorphous nymphs of *Tyroglyphus* and some allied genera.

3. That it is not all individuals that become *Hypopi*, but only a few.

4. That the hypopial period takes the place of that between two ecdyses in the ordinary life-history.

5. That, in those species which I have examined, the hypopial stage commences with the second nymphal ecdysis.

6. That the change to *Hypopus* is not caused by unfavourable circumstances, and is not any extraordinary or exceptional circumstance, but is a provision of nature for the distribution of the species occurring irrespective of adverse conditions.

7. That, in the present state of our knowledge, we can no more say why one nymph becomes a *Hypopus* and another does not, than we can say why one ovum produces a male and another a female.

8. That *Hypopi* are not truly parasitic, but only attach themselves to insects, &c., for the sake of conveyance, and that they do not confine themselves to any particular insect, but adhere to any suitable moving object.

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nous hood covering the front part of the body of the female, and other things would, I think, prevent both species being properly included in one genus. I think Berlese was in error in considering *Pygmephorus* to be an immature form.

9. That the external form of *Hypopus* is a protective provision given to some *Acarina* which have to be distributed by attaching themselves to insects or other creatures, which will expose them to heat and draught that would kill them, were it not for this protection; and that the protective dress may be given either to immature or adult creatures.

10. That the creature which I have called *Disparipes bombi* is an adult aud a separate species of which the females only have assumed what may be called the hypopial dress, and are parasitic, probably as a means of conveyance.

11. That there appear to be other species of the same genus.

12. That probably Donnadieu's bee-parasites are adult species as he says, but that it is not absolutely certain that they are identical with Dufour's *Trichodactylus*.

Order ACARINA.

Suborder Tracheata.

Family Myobiadæ.

Genus Disparipes.

Characteristics of the Genus.—Legs dissimilar. First leg terminated by a single claw, without caruncle, and second and third legs by a double claw, with or without a caruncle, in both sexes. Fourth legs much thickened, terminated by very long setæ without claw or caruncle; setæ different in the two sexes. Anterior part of female entirely hidden beneath a chitinous carapace. Rostrum articulated to cephalothorax, and bearing four rod-like projections; other mouth-organs rudimentary, or very slightly developed.

Disparipes bombi, gen. nov. Plate XV.

Male (fig. 1). Average length, about ·22 mm.
„ breadth, about ·12 mm.
„ length of legs, 1st pair, ·11 mm.
„ „ „ 2nd pair, ·10 mm.
„ „ „ 3rd pair, ·11 mm.
„ „ „ 4th pair, ·07 mm.

Colour semitransparent white, with a yellowish shade in parts. A large shield-shaped space at the posterior end of the notogaster brown. The excretory organs show through the dorsal surface, forming a large, opaque, white mark.

Texture rough and leathery, not hard nor chitinous.

General form an elongated diamond, with curved sides.

Cephalothorax and abdomen. Rostrum very small and colourless, articulated with the cephalothorax; sides almost parallel; two short rod-like or tubular projections from the anterior border of the rostrum, and two similar, but rather larger, inserted in a notch in the side of the rostrum, like palpi. No demarcation between cephalothorax and abdomen; hinder portion of notogaster covered by a brown, chitinous, shield-shaped plate, not quite coming to the edge of the abdomen; the soft parts outside the plate ragged in outline and bearing a few short, clear spines. Notogaster bearing four rows of very large serrated spines. No part of the creature covered by any carapace.

Legs of 5 free joints; there is also a large basal portion which may be an epimeron, or may be equivalent to a fixed coxa. First pair articulated to the anterior margin, gradually diminished in thickness towards the distal extremity; every joint bears one or more whorls of large spines; there are several on the tarsi; which are terminated by small *single* claws on long straight peduncles, with a very large serrated seta above it and another nearly opposite. Second and third legs articulated at the side of the body, slightly below; somewhat similar in shape to the first pair, but tarsi more curved, and terminated by a didactyle claw, with caruncle; setæ smaller than those of the first leg, but the penultimate joint of the second leg bears a curious curved chitinous projection on the outside and a strongly pectinated seta on the inside. Fourth legs short, but very thick, curved inward, ending bluntly; no claw nor caruncle, but two long setæ not quite terminal, the upper one being the longer. There is a large spike on the inside of the penultinate joint directed downward and backward, and a curved chitinous projection on the outside, as in the second leg. A few other setæ on the legs.

The *ventral surface* shows a median chitinous ridge, or sternum, with four transverse ridges or apodemata running to the epimera of the legs, and forming the skeleton. These divide the body into eight spaces, each of which bears two or more clear spikes.

The penis is long and straight, and is seen in the median line below the shield-shaped plate.

Female (figs. 2, 3).

Average length about ·26 millim.

Average breadth about ·22 millim.

Average length of legs—1st and 2nd pairs about ·06 millim.; 3rd and 4th pairs about ·08 millim.

Colour. Yellowish chitinous-brown, of medium tint. The white excretory organs show through the dorsal surface, as in the male.

Texture. Chitinous, hard, and polished, particularly the anterior part of the carapace, which is slightly transparent.

General form oval, but so short and broad as to be nearly circular. This form varies a little, not only in different specimens, but in the same, according to the action of the muscles, the lateral parts of the carapace being slightly flexible.

The whole of the anterior part of the body is covered by a semilunar buckler, greatly resembling that of *Limulus.* This buckler projects far beyond the body both anteriorly and laterally, and extends as far back as the insertion of the 4th (posterior) pair of legs. The three anterior pairs of legs are entirely covered by this buckler when the creature is at rest, and almost covered by it at other times. The portion of the body posterior to the insertion of the 4th pair of legs is also covered by a projecting carapace; but this, instead of being fused into one mass, is clearly divided into three segments.

Cephalothorax. Small, much more distinctly divided from the abdomen than in the male. Rostrum shorter, broader, and more chitinous than in the male; it is usually carried folded down against the ventral surface. The mouth-organs, which are difficult to make out, appear less rudimentary than those of the male. The anterior pair of rod-like projections have become more substantial organs.

The abdomen, although much smaller than the carapace, is large in proportion to the cephalothorax; it approaches the circular form, but on the ventral surface bears a thin, colourless, shield-shaped plate, more plainly seen at its anterior than its posterior limit, the anterior angles projecting and covering the insertion of the third pair of legs.

There are two rows of colourless spines on the dorsal surface of the carapace, which may stand upright or lie backward; a few similar spines nearer the edge, and two smaller pairs near the posterior margin. There is a sternum, apodemata, and epimera, forming a skeleton on the ventral surface, as in the male.

Legs. The first two pairs rather the shortest, the first pair thicker than any other (except the basal joint of the fourth).

The first leg (fig. 6) has the tarsus and penultimate joint fused into one considerably enlarged mass, as in *Pygmephorus*, terminating anteriorly in a clear, chitinous projection, which carries an extremely large, sharply-bent, monodactyle claw, without sucker or caruncle. The enlarged terminal joint has a thinner ridge on its upper surface, bearing two very long hairs or spines, with two laurel-leaf-shaped pieces and a short spike between them. There are two strong curved hairs on the underside of this joint, and a few similar on the other joints. The second and third pairs of legs have the tarsus terminated by a didactyle claw, with a small caruncle between the ungues. These legs are abundantly haired, but there is not any hair which attains special prominence. The fourth pair of legs (fig. 9) have the first (basal) joint very thick and long; the other joints diminish in size regularly and rapidly. The tarsus does not bear any claw or caruncle, but terminates in two extremely long and powerful setæ, of which one is straight and the other curves towards it; the same joint bears three other curved setæ, which are smaller, but still large, and there are one or two setæ on the other joints.

The whole body is attached to the dorsal carapace by a membrane, which covers the ventral surface and lines all parts of the carapace.

The alimentary canal shows plainly from the dorsal aspect. It consists of a long œsophagus, forming a slight ingluvies at the posterior end; a valve divides this from an almost globular ventriculus, from the posterior end of which proceeds the hind gut, very obscure, and almost entirely or quite hidden by the opaque-white excretory organs which overlie it. From these last-named organs a straight median passage may easily be traced to the anus, which lies at the posterior edge of the carapace (ventral surface).

From the ventral aspect a main tracheal trunk may be seen on each side, proceeding from the rostrum and running nearly straight backward below the alimentary canal, and there are important tracheæ supplying the legs &c.

All the internal organization can be seen much more plainly in the female than in the male.

Larva.

Colourless, semitransparent. Texture smooth, almost polished. General form elliptical, margin lobed. The creature shows segmentation very clearly. Rostrum oblong, almost square, hardly seen from above, being much folded down on the ventral surface; it is also very retractile, capable of being almost entirely withdrawn into the camerostomum; it bears two pairs of short setæ, but these do not spring from a tube as in *Hypopus*. There are a few smaller hairs. The dorsum is nearly covered by three transparent chitinous plates, slightly imbricated; they do not reach the lateral margin, and are rounded towards it. The first plate bears two pairs of large serrated spines slightly curved: each of the other plates bears one pair. There are two smaller similar plates on each side, each plate bearing a similar spine. Beyond these plates the margin is membranous; this part is wide posteriorly, and divided into large lobes all round. The posterior termination of the abdomen is a retractile lobe or segment, bearing two pairs of very long curved spines, of unequal length, the shorter being the thicker and most strongly serrated.

The legs are about half the length of the body, approaching conical, almost straight; coxæ thick; joints gradually diminishing; tarsi slightly curved when seen from the side; from that view they end very bluntly, and all three pairs are terminated *by a strong didactyle claw* on a slender peduncle. Two very long flexible setæ are inserted near the distal end of the first tarsus, shorter ones on the other legs; all the joints have several shorter spines. The creature is very mobile, and can lengthen and shorten its form considerably.

The egg is almost globular, milky-white, and without any conspicuous markings.

DESCRIPTION OF PLATE XV.

Disparipes bombi.

Fig. 1. Larva. Dorsal view, × 400.
2. Adult male. Dorsal view, × 200.
3. Adult female. Dorsal view, ×150.
4. Adult female. Ventral view, × 150.
5. Tarsus of first leg of male, side view, × 600.
6. First leg of adult female, × 800.
7. Claw of same leg (from within).
8. Ungues and caruncle of second leg of adult female.
9. Fourth leg of adult female, × 500.

On some Structures liable to Variation in the Subfamily Astrangiaceæ (Madreporaria). By Stuart O. Ridley, M.A., F.L.S., Assistant in the Zoological Department, British Museum.

[Read 21st February, 1884.]

(Plate XVI.)

It is one of the chief functions of Zoology (as distinguished from Comparative Anatomy) to bring together the (essentially) like and to separate the (essentially) unlike. The question, What constitutes essential similarity and dissimilarity? is one of the earliest problems which confront the zoologist, and, if not satisfactorily solved, will prove a stumbling-block at every turn; it is, moreover, as applied to the lower terms of our classification, viz. genera and species, a question with which *à priori* considerations have very little to do, and which can only be satisfactorily solved, as a rule, by study of a tolerably extensive series of the very genera and species to which the problem is to be applied.

Perhaps in no group is it more necessary to bear these facts in mind than in the Madreporarian Corals. The constantly decreasing value placed upon certain structures, viz. tabulæ, cœnenchyma, and epitheca, and upon the number 6 as an index to the septa for group-distinction, illustrates the truth of this. In the families Turbinoliidæ and Oculinidæ the characters derived from the presence or absence of the numbers of the pali, from the structure of the columella, and (but to a less extent) the condition of the costæ, form leading points for generic and specific diagnosis. In that group of the great family Astræidæ, as at present constituted (Milne-Edwards and Haime), which probably shows the closest general resemblance to these families, viz. the Astrangiaceæ, the columella, costæ, and pali form lobes representing physiologically the pali, inasmuch as they frequently exhibit a similarly advanced development, and have been naturally resorted to for purposes of classification *. But the object of this paper is to show that, whatever may be the value for classification of the corresponding parts in the Turbinoliidæ and Oculinidæ, they must be employed with great caution in the zoological study of the Astrangiaceæ.

* See Duncan, Proc. Zool. Soc. 1876, p. 439; Verrill, Bull. Mus. Comp. Zool. i. p. 47, Trans. Conn. Acad. i. p. 525 *et seq.*; Milne-Edwards and Haime, Hist. Nat. Cor. ii. pp. 606–620.

The facts on which I base this argument will be found in the following descriptions of two species of *Phyllangia*. I had been led to examine these species closely for the purpose of identifying some specimens lately added to the national collection; I found that they were somewhat "critical" species, and that one of them was incorrectly identified in the collection; and that, further, certain of the characters on which stress had been previously laid by describers of species proved remarkably unstable. For these reasons I now give descriptions of two series of specimens illustrating these two species.

PHYLLANGIA PAPUENSIS, *Studer*. (Plate XVI. figs. 5–10.)
Phyllangia papuensis, *Studer, MB. Ak. Berlin*, 1877, p. 642.

The specimens consist of fragments detached from an old anchor at Amboyna by Mr. H. O. Forbes, and presented by him to the British Museum. Studer's description of specimens from the Solomon Islands differs from them in a few points, viz. the inferior diameter of the calicles (4–5 millim., the largest of the present series examined is 7 millim.), and the "*small*" paliform lobes. He describes the columella as small, consisting in some cases of only one to three short pillars.

In the Amboyna specimens the basal stolon is moderately thick, the corallites are 8–9 millim. in greatest height, the primary septa in large calicles rise 1 millim. above the wall of the cup; it is the largest calicles which have the thinnest primaries; septa of a fourth cycle may be present on one side of some systems of a calicle. The central (columellar or pseudo-columellar) mass is usually composed of *one* roughly pointed, prominent, central column (the columella s. str.), and of six to ten erect similar paliform lobes arising from the inner margins of the primary and some secondary septa, and of subjacent contort, rather coarse trabeculæ uniting them to the columella: these trabeculæ may (i.) either be evident from above, the paliform lobes and columella forming inconspicuous points on their upper margins, or (ii.) these structures may project boldly from the trabeculæ, or (iii.) the trabeculæ may be disguised and the spaces between them concealed by the extension between the trabeculæ, lobes, and columella of a calcareous lamina, uniting the whole into a dome from which the lobes and columella arise as pinnacles (see figs. 7–9).

The costæ are broad, flat, subequal, and granular, and extend in bold sweeping curves, sometimes rising into quite prominent ridges and bending at sharp angles between the calicles. The calicles are circular or slightly subcircular, maximum diameter 7 millim. Tertiary septa dentate above; all septa with approximately vertical inner margin; surfaces of the first three orders in a few cases sparsely and finely granular.

Increase of the colony takes place by gemmation, either (*a*) from the sides of older corallites, the interseptal cavities of the older and younger being (in some cases at any rate) in communication; (*b*) from the basal stolon (see fig. 10).

I would call special attention to (1) the variability of the central columellar mass in large corallites from (i.) a continuous dome-like calcareous mass from which the columellar pillar and the paliform septal lobes rise prominently, to (ii.) a spongy aggregation of plicate laminæ, the upper margins of which are scarcely resolvable into distinct columellar columns and paliform lobes; in other words, *from the papillose to a trabecular type*; and (2) to the variation in the source of the gemmation, viz. from the stolon to the sides of the calicles; MM. Milne-Edwards and Haime state that in this group the former mode alone obtains. Verrill (Tr. Conn. Ac. i. p. 525) has already pointed out that in *Astrangia* both methods occur.

PHYLLANGIA DISPERSA, *Verrill*, var. (Plate XVI. figs. 1–4.)

Phyllangia dispersa, *Verrill, Bull. Mus. Comp. Zool.* i. p. 47; *Trans. Conn. Acad.* i. p. 532.

In a specimen coating the umbonal region of a bivalve shell from deep water, Malacca, in the National collection, the common basal lamina is thin; in one case a good-sized corallite rises from the lamina in such a way that the wall is continued by a gradual curved sweep into the lamina, on to which some of the costæ are faintly continued; the remaining corallites rise abruptly from the lamina, and the costæ can rarely be distinctly made out to be continued on to the lamina. Although some of the calices are of fair size, viz. 5·5 millim. in the greater diameter, this wall is very thin, and the maximum height is only 4·5 millim. The calicles vary from a circular to an elliptical form, the disproportion of the axes in the latter reaching as much as 11 : 9; the costæ are either (i.) low, extending to the foot of the corallites —those of the primaries, and sometimes of the secondary septa, standing further out from the wall than the rest—or (ii.) they are subequal, or (iii.) they are wanting (on one part of a corallite). The columella is composed of minute, rather contort, and sublaminar papillæ, to which the interior and inferior terminations of some of the secondary and tertiary septa (and rarely the primary also) contribute a very thin horizontal laminar ridge or foot, which is minutely dentate in the case of the secondary and tertiary septa. This ridge is a "paliform lobe" in a most rudimentary condition, and in some cases can be called no more than the inward prolongation of the lower margin of the septa. The septa occur in four cycles, of which the fourth is frequently wanting; the primaries rise nearly 1 millim. above the wall, slope off gradually towards the middle of the calicle, and their inner edge falls almost perpendicularly downwards from a point which is about on a level with the margin of the wall, where the septum is about 1·25–1·5 millim. wide; the sides are finely striated; the secondaries may project about ·3 millim. above the margin, but both these and the tertiaries scarcely project inwards at their upper termination at all, but slope off gradually by concave margins until they join the columella as above described; the quaternaries also project but slightly into the interseptal spaces, and either fall almost perpendicularly at once into these spaces, where in some cases they may be seen extending a horizontal lamina towards the columella at a considerable depth, or attach themselves laterally to the adjoining septa. All the septa resemble tissue-paper in their thinness, and the secondary, tertiary, and quaternary have fine but prominent granules on their faces; the primaries and secondaries and the upper parts of the rest have the margin entire; the subhorizontal inner portion of the tertiaries is finely dentate. Verrill's specimens and those in the British Museum from Punta Arenas agree with each other, and differ from the Malacca specimens in the granulated (not striated) condition of the primary septa, and the variability in extent of the columella, and in the occasional minute denticulation of the edge of the primary septa. Even allowing for individual differences and the possible influence of depth, this species must be distinguished from *papuensis* by the inequality of the costæ, the minute numerous papillæ of the columella, and the rudimentary condition of the paliform lobes.

I would call attention to two points in this species, viz. (1) the variability of the costæ (*a*) as regards actual prominence, viz. from practical absence to moderate development, and (*b*) as regards relative prominence, viz. from a subequal condition to one in which the upper parts of the primary and secondary costæ much exceed the others; (2) the occurrence in some individual corallites of some teeth on the margins of the largest septa (Verrill gives "sub-entire primary and secondary" septa as a generic character for *Phyllangia*, Tr. Conn. Acad. i. p. 532; and in Astræidæ proper the dentation or not of the septal margins is employed by Milne-Edwards and Haime to separate the Eusmilinæ from the Astræinæ).

The few points above noted being too slight or too variable to distinguish the Malacca specimens from those found on the west coast of America, the known distribution of *P. dispersa* assumes the following remarkable condition:—

Hab. Panama and Pearl Islands, W. coast of America (*Verrill*); Punta Arenas, Central America (*coll. Mus. Brit.*); Malacca (*coll. Mus. Brit. ex coll. Belcher*).

The Malacca specimen was (perhaps partly on distributional grounds) originally identified as *P. papuensis* in the National collection.

I lay these observations before the Society feeling that it is only by careful observation and record of the constancy or inconstancy of the different characters in different groups that right principles can be obtained for the distinction of genera and species.

DESCRIPTION OF PLATE XVI.

Fig. 1. *Phyllangia dispersa.* Specimen from Malacca, upon valve of *Cardita*, which also supports an incrusting Polyzoon. × 2 diam.

2. The same. Part of the outer surface of a calicle from this specimen showing well-marked costæ. × 6 diam.

3. The same. Part of the outer surface of a calicle from same specimen, showing costæ merely indicated. × 6 diam.

4. The same. A calicle from same specimen, as seen from above. × 3 diam.

5. *Phyllangia papuensis.* Basal view of two calicles, from fragment of colony scaled off anchor from Amboyna, showing the characters and distribution of the dissepiments. × 3 diam.

6. The same. Part of a colony modified by growth around a seaweed or hydroid stem. × 2 diam.

7, 8, 9. The same. Three calicles from large colony from Amboyna (fig. 10), as seen from above, to show range of variation in the columellar mass. × 3 diam.

10. The same. Fine colony, showing great range in height of calicles and characters of the columellar mass. × 2 diam.

Closure of the Cyclostomatous Bryozoa.

By Arthur Wm. Waters, F.L.S., F.G.S.

[Read 20th March, 1884.]

(Plate XVII.)

As my description of the Australian fossil Chilostomata progressed, I have known that the Cyclostomata must shortly be dealt with, and have looked forward to this with feeling almost of dismay, because the Cyclostomata possess so few characters that can be used for the purposes of determination. In consequence, for some time sections of such Cyclostomata as were available were prepared and examined, to see what other points might be used for the purpose. Although the results are very small in proportion to the amount of work, yet I shall in my forthcoming paper to the Geological Society be able to point out that the ovicells ought to be very carefully examined, as there are more points of importance than have so far been used, and shall call attention to the connecting pores being comparable with the rosette-plates of the Chilostomata, and giving, by their position, useful characters. Stress must be laid upon the size of the zoœcial tube, as this, as already pointed out by Smitt, seems to be constant in each species. The range in size of the zoœcial tube is not very great; the smallest being only 0·03 millim., while some are nearly 0·2 millim.; but it is quite exceptional to find zoœcia more than 0·14 millim., or less than 0·07 millim.

Besides these, there is another character which has never been understood and is quite neglected, and which may possibly be of great use; but to what extent, it is impossible to say at present. I refer to the position of the closure of the zoœcial tube. As a correct understanding of it has a most important bearing not only upon a large number of living species, but also on several groups of fossils, some of which are still of a more or less problematic character, I am anticipating my descriptive paper by dealing with this at present, in order that it may be more fully studied from various stand-points by those who have the opportunity.

In the 'Crag Polyzoa,' p. 110, Mr. Busk speaks of the mouths of the tubes of *Mesenteripora* being eventually closed by a calcareous lid having usually a minute central perforation. Smitt figured the cover with a projecting tubule in what he called

Reticulipora nummulitorum, d'Orb., but which I afterwards named *R. dorsalis*, from Naples ("Bry. of Naples," Ann. & Mag. Nat. Hist. 1879, iii. p. 278, pl. xxiii. fig. 5), and figured a similar cover with a projecting tubule; and since then Mr. Hincks has figured the same thing in *Diastopora sarniensis* ('Brit. Polyzoa,' p. 463, pl. lxvi. figs. 7–9), and refers to their having been considered subservient to reproduction; but none of us fully appreciated that this closure is only a modification of what occurs in the zoœcial tubes of all Cyclostomata.

Mr. J. Young, in the 'Geological Magazine' (new series, vol. i.), called attention to *Polypora*, Carboniferous Bryozoa having the aperture nearly closed by a thin calcareous cover with a minute opening in the centre. These closures, which are nearly terminal, have been thought to be homologous with the radial denticles of *Glauconome stellipora*; and the existence of this calcareous cover in Palæozoic Bryozoa has attracted considerable attention. In "Remarks on some Fenestellidæ," Manch. Geol. Soc. 1878, I mentioned, as bearing upon the last point, that "in the Cyclostomata the cells are often after a time closed by a diaphragm, in most cases some little distance down the tube;" and further examination enables me now to state that the position and the character of this diaphragm may be employed as a useful specific character.

The most usual position for the calcareous plate which closes the tube would seem to be about the point where the zoœcial tube rises free from the zoarium. This can very well be seen in what I call *Entalophora rugosa*, d'Orb., from Naples; and in successful sections we cut through this plate and see it as figured (Pl. XVII. fig. 3). In *Idmonea* the closure is usually in about the same position as in *E. rugosa*, while in *Crisia* it is terminal; and we have seen that in *Mesenteripora* and some *Diastoporæ* it is terminal with a projecting tubule, and in several Palæozoic fossils it is almost terminal.

Besides the position, we must also notice the character of this plate; for sometimes it has one opening, in other species there are a number of openings, as figured by Hincks in *Diastopora patina*, or there may be only very minute perforations, and it is apparently sometimes quite closed.

Mr. F. D. Longe published a paper in the 'Geological Magazine' (Jan. 1881), "On the Oolitic Polyzoa," in which he maintains that certain closures are the equivalents of the opercula of the Chilostomata; but I do not think that there is any necessity for dealing in detail with the conclusions that Mr. Longe drew; for doubtless he will now consider that it is made clear that the structure of the movable horny operculum, and the calcareous plate across the opening of the Cyclostomatous tube, is very different. I would also point out that there are, as far as I have seen, differences of shell structure which distinguish the Oolitic Chilostomata and Cyclostomata; and a number of characters would enable the "race Diastoporidæ" of Longe, containing *Diastopora*, *Entalophora*, *Eschara*, and *Cellepora*, to be readily divided into their two suborders.

It will be noticed in the Plate (figs. 5 & 6) that sometimes instead of only one closure there are two quite close together. I am not able to give any definite explanation of this; but it must be looked upon as having a very important bearing upon the tabulæ in *Heteropora*; and *Heteropora* having been made the basis of comparison with the *Monticuliporæ* and allied fossils, these tabulæ should be very carefully examined.

Mr. Busk, in the 'Crag Polyzoa,' p. 122, speaks of partial transverse nearly equidistant septa "* in *Heteropora*; but unless properly made sections have been prepared, there is a great chance of being misled by appearances, and from fig. 2 of pl. xix. I feel no doubt whatever that there were no tabulæ in the part of the specimen figured by Mr. Busk, as I believe transparent sections would have shown, whereas apparently only a broken surface was examined.

As pointed out †, I have made many sections of *Heteropora* without finding tabulæ; and as their presence indicates a stage of growth or decay, they will not always be present. On the other hand, I have now found closures in a number of cases, usually only one in a zoœcial tube; but besides the closures near to the circumference, there are sometimes others nearer to the centre of the zoarium; but in no case in recent, Tertiary, or Cretaceous Heteroporidæ have I found numerous tabulæ, whereas in what Haime calls *Heteropora conifera* I find the tabulæ most frequent, just as figured by Haime ('Bry. Jur.' pl. xi. fig. 2), and they only average about 0·2 millim. apart.

In *Heteropora* (*Multicavea*) *lateralis*, d'Orb., from Royan, I find

* This term septa has been objected to by Prof. A. Nicholson; and a protest must also be made against the term opercula for these plates.

† "Note on the Genus *Heteropora*," Ann. & Mag. Nat. Hist. vi. p. 156 (1880).

that one zoœcial tube has a double closure (fig. 6), as mentioned above; and the same thing may be seen in a *Reticulipora* fossil from Aldinga, Australia, which I call *R. transennata.*

In a *Radiopora* from St. Croix these divisions, instead of being irregularly placed as in *H. conifera*, occur at longer intervals, and then in the neighbouring zoœcia they are frequently at an equal distance from the centre of growth, thus forming, when slightly magnified, almost concentric lines cutting across a number of zoœcia. The section of *Lichenopora boletiformis* shows the structure of an Australian fossil, which in its shape and general appearance partly resembles *Radiopora*; but the way in which it grows will be seen to be quite different. If we turn to Simonowitsch's 'Beit. z. Kennt. der Bryozoen des Essener Grünsandes,' I think we see both structures; for in fig. 4, pl. i., we seem to have a *Radiopora*, while figs. 2 and 3, pl. ii., seem to represent a *Lichenopora* growing like *L. cochloidea*, d'Orb., or *L. boletiformis*, d'Orb.; and in such cases there is probably a basal lamina as in the Australian fossil.

It certainly does not seem that we can in any way directly compare this immovable closure with the movable operculum of the Chilostomata; but at the same time the object may not be entirely dissimilar. To understand this, we must always keep in mind that with the death of the polypide, or perhaps it is better to say the absorption, the colony continues its life, and in the case of Chilostomata a new polypide may grow in the zoœcium recently occupied; but to what extent this is the case in Cyclostomata I do not find any direct observations. Now if each zoœcium during its polypideless condition could be choked up by the mud deposited from the sea, then the whole colony must suffer from the absence of the individual polypides which kept the living tissue free, and the death of the colony would result.

In the Cyclostomata, which are the simplest of the Bryozoa, a calcareous partition exists which closes the tubular zoœcium, and thus protects the colony; whereas in the Chilostomata, which are more highly differentiated and, not being tubular, could more easily be closed up, there is the horny operculum, which is not a sign of death, but is movable, and protects the living polypide and through it the colony. I have already carried this idea further and applied it to avicularia (Quart. Journ. Geol. Soc. vol. xxxvii. p. 327, and vol. xxxix. p. 425); for the avicularia retain their life and power of movement when no polypide fills the cell, and thus important tissues of the colony are kept in healthy contact with the exterior.

The form of the aperture in the Chilostomata has been recognized by all recent authorities as being of the first importance in determination; and I showed* that the opercula furnish the most reliable specific characters: and these, in the hands of Mr. Busk for *Cellepora*, and Professor MacGillivray for *Retepora*, have given most important results. In all examinations that I have made of fossils the shape of the opercular opening has always been studied where it was possible; and in the same way with the Cyclostomata the examination of the shape and size of the aperture and the nature of the closure is likely to extend our knowledge; and, further, it is only possible to check the naturalness of classification where many characters are available, for then the correlation of these characters will show when we are upon the right track. Such points as we have been dealing with can, however, only be made available by extended study, and my present work is not favourable for this; as with fossils, especially those sent from a distance, there is in many cases only one specimen, whereas there should be abundant material at hand, and in various conditions of growth.

DESCRIPTION OF PLATE XVII.

Fig. 1. Section of *Radiopora* from the Valangian of St. Croix, Switzerland.
2. Section of *Hornera concatenata*, Rss., from the Bartonian of Brendola, N. Italy.
3. Section of *Entalophora rugosa*, d'Orb., recent, from Naples.
4. Closure of *Reticulipora dorsalis*, Waters, recent, from Naples.
5. Section of *Reticulipora transennata*, Waters, in present volume of Proc. L. Geol. Soc., fossil, from Australia.
6. Section of *Heteropora* (*Multicavea*) *lateralis*, d'Orb., from the Senonian of Royan, France.
7. Section of part of colony of *Lichenopora boletiformis*, d'Orb., fossil, from Aldinga, Australia. ×12.
8. Section of *Lichenopora boletiformis*, d'Orb. ×7.

* "The Use of the Opercula," &c. Proc. Manch. Lit. & Phil. Soc. vol. xviii. No. 2, p. 8.

Contributions to the Ornithology of New Guinea. By R. Bowdler Sharpe, F.L.S.—Part IX. On further Collections made by Mr. A. Goldie in the Astrolabe Mountains.

[Read 17th April, 1884.]

It is now some time ago since Messrs. Salvin and Godman showed me a collection of birds forwarded to them by Mr. Goldie, but pressure of official work at the British Museum during the removal of the zoological collections to Kensington has not allowed me the time to study them until quite recently. A few of the birds have passed into the national collection, and three of these possess more than ordinary interest.

Order ACCIPITRES.

Subfam. Buteoninæ.

Erythrotriorchis Doriæ.—Megatriorchis Doriæ, *Salvad. & D'Albert. Ann. Mus. Civic. Genov.* vii. p. 805 (1875); *Salvad. Orn. Papuasia &c.* i. p. 41 (1880).

Adult. General colour above glossy black, with nearly obsolete rufous margins to the feathers of the upper surface; wing-coverts black, very plainly and broadly edged with chestnut; bastard-wing and primary-coverts black, with indistinct bars of ashy brown, nearly obsolete on the bastard-wing; quills black, barred across with brown, these bars less distinct on the inner webs; tail-feathers black, barred with ashy grey, about twelve bars being discernible on the central feathers; the outer tail-feathers with about the same number of brown bars, as well as one at the tip; crown of head uniform black, the nape crested; feathers below the eye and the ear-coverts black, the feathers edged with rufous buff, imparting a streaked appearance; cheeks and throat rufescent buff, streaked with black down the centre of the feather; remainder of under surface white, streaked broadly with black, and marked slightly with chestnut, especially on the sides of the body; the black bars rather broken up, and in the form of large spots on the flanks, abdomen, and under tail-coverts; thighs broadly barred with black and white, with a chestnut spot in the centre of the black bars; under wing-coverts black in the centre, rufous or rufous-white on the edges; the lower series blackish, barred with ashy or greyish white like the lower surface of the quills. Total length 20 inches, culmen 1·05, wing 12·8, tail 10·0, tarsus 3·1.

After carefully examining this curiously marked Hawk, I came to the conclusion that it must be *Megatriorchis Doriæ* of Salvadori and D'Albertis; and on applying to my friend Marquis Doria, he very kindly sent me over the type of the latter bird for comparison. I am confirmed in my opinion that in the bird described above we have the first known example of the adult in any collection; and I now give a detailed description of the typical specimen of *M. Doriæ*, which is apparently a young bird.

Young female (type of species). General colour above brown, barred regularly across with lighter brown, the edges of the feathers rather more rufous or fawn-coloured; head brown, streaked with rufous, the feathers edged with this colour, and having creamy white bases; the ear-coverts a broad eyebrow of white feathers streaked with black; a small crest of pointed plumes; nape-plumes white, with a rufous tinge, and mesially streaked with black; hind neck like the back, but more mottled with black spade-shaped terminal spots to the feathers; wing-coverts ashy brown, tipped with fawn-colour, and broadly barred across with darker brown; quills ashy brown, broadly barred across with blackish brown for their entire length, the interspaces on the secondaries lighter, these quills being much paler tipped; upper tail-coverts and tail-feathers ashy brown, tipped with greyish, slightly tinged with rufous on the former, the tail-feathers crossed with twelve bars of blackish brown; sides of face and ear-coverts white, the feathers mesially streaked with dark brown, the ear-coverts tipped with blackish brown, forming a distinct patch; under surface of body creamy white, streaked with dark brown, very narrowly on the throat, broader on the abdomen and lower breast, the thighs and under tail-coverts with nearly obsolete mesial streaks; fore neck and breast broadly streaked with light rufous, browner on the former, the breast-feathers with a shaft-streak of dark brown; under wing-coverts and axillaries white, with a dark brown shaft-streak; quills ashy below, white near the base, barred with dark brown, the bars about nine in number; "bill black, the cere and eyelids ash-colour; feet whitish grey; iris chestnut-brown" (*D'Albertis*). Total length 7·5 inches, culmen 1·7, wing 13·7, tail 12·8, tarsus 3·4. (*Mus. Genuensi.*)

Hab. Monte Epe, S.E. New Guinea.

At the same time it is evident that the genus *Megatriorchis* is not distinct from *Erythrotriorchis*, Sharpe, P. Z. S. 1875, p. 337, and the species will have to stand as *Erythrotriorchis Doriæ*.

Suborder STRIGES.

Fam. BUBONIDÆ.

NINOX THEOMACHA (*Bp.*); *Sharpe, Cat. B.* ii. p. 178.

A specimen sent by Mr. Goldie is undoubtedly *N. Goldiei* of Mr. Gurney, and, I think, is the same as *N. terricolor* of Ramsay. I incline to the belief that both are identical with *N. theomacha* of Bonaparte, although I admit that the very much larger size of *N. Goldiei* and its less uniform under-surface seem at first to separate it from the smaller *N. theomacha*, of which the Museum has an example also from the Astrolabe Mountains. The latter is a male, and the specimen of *N. Goldiei* is a female, so that, until contrary evidence is adduced, I shall consider *N. theomacha* is the male and *N. Goldiei* the female of the same species; although I admit that the difference in size of the sexes is rather more than is usual in the genus *Ninox*. I append a full description of the adult female (=*N. Goldiei*).

Adult. General colour above nearly uniform sooty brown, with a chocolate tinge on the mantle and scapulars, the latter of which have a few scattered white or reddish-white spots on the outer web; wing-coverts uniform and like the back, the median and greater coverts alone having some spots of white here and there on the outer web, the greater series somewhat tinged with chocolate-brown; bastard-wing, primary-coverts, and quills blackish brown or dark sepia, the quills rather browner externally, and barred indistinctly with greyish or ashy brown, the innermost secondaries with a few scattered white spots on the outer web; tail uniform sooty brown, with a few lighter bars towards the base of the inner web of the central feathers; head uniform sooty or dark ashy brown, more inclining to chocolate brown on the forehead; lores greyish white, with dusky shaft-lines extending above the fore part of the eye; cheeks and ear-coverts uniform dark ashy brown; throat ashy fulvous, with dusky centres to the feathers; sides of breast and fore neck uniform warm chocolate-brown; the remainder of the under-surface chocolate-brown, plentifully mottled all over the breast, abdomen, and flanks with large white spots and dusky cross bars, the spots rounder on the breast, and squarer and larger on the flanks; thighs tawny, mottled with chocolate-brown centres to the feathers; under tail-coverts pale tawny buff, mottled like the breast with brown bars and large rounded white spots; under wing-coverts dark chocolate-brown, the inner ones and axillaries pale rufous on their edges; greater under wing-coverts blackish below, with broad bars of white on the inner web; quills blackish below, with obsolete paler bars on the inner web, rather plainer near the base, the first primary hoary white near the base of the outer web, and notched with hoary white for the greater part of the latter. Total length 12 inches, culmen 0·75, wing 8·7, tail 5·0, tarsus 1·25.

Fam. PARADISIIDÆ.

Genus AMBLYORNIS.

AMBLYORNIS SUBALARIS, sp. n.

Differs from *A. inornatus* in being more dingy in colour below, being dusky brown, with fulvous centres and narrow fulvous shaft-lines; under wing-coverts and inner lining of quills rich ferruginous, instead of orange-buff. Total length 8 inches, culmen 0·9, wing 4·65, tail 3·4, tarsus 1·4.

On the Anatomy and Functions of the Tongue of the Honey-Bee (Worker). By TRAVERS JAMES BRIANT. (Communicated by B. DAYDON JACKSON, Sec.L.S.)

[Read 3rd April, 1884.]

(PLATES XVIII. & XIX.)

IN order to arrive at a just appreciation of the relationship of the tongue of the Bee to the rest of the head, it will be necessary to refer to the more conspicuous parts of the endo-skeleton to which it is related.

From the lower half of the ring which surrounds the occipital foramen arise two pillars (*a*, fig. 1, longitudinal section of head, without muscles; fig. 2, horizontal section, with muscles), which pass obliquely downwards to the front wall of the head, and there blend with two ridges that correspond inwardly with the furrows, which, on the outer surface, mark off the clypeus. From the lower side of the base of each of these pillars spring second pillars (*b*, figs. 1 & 2), running parallel with those first mentioned until they approach the outer wall of the head, where they terminate in a bifurcation; they cannot, however, in strictness be considered pillars, as they each unite with and form part of the chitinous wall bounding the oral chamber.

This bifurcation receives the end of the cardo (*d*, figs. 1, 2, & 5, details of the base of maxilla, with adjacent parts). The cardo is channelled on the medial side and terminates at each end in two unequal processes, those at the forward end receiving the muscle *ex m*, those at the other being hinged to the base of the maxilla (see fig. 5); in the centre of this fork is placed the end of one of the wings of the lora (*e*, fig. 3, longitudinal section of head, with muscles; figs. 5 & 6, tongue of queen from above). The central portion or body of the lora is triangular in shape and is hinged to the base of the mentum.

The mentum is a semitubular body, bearing at its anterior end the labial palpi, the tongue, and the other organs connected with it. It contains the muscles acting directly on the tongue, and the salivary valve; and into it is withdrawn a large portion of the basal end of the tongue in the manner hereafter to be described. The anterior end (fig. 15, from above) is cut by two longitudinal notches; the central portion bears the paraglossæ, the hyaline rod which traverses the tongue (*l*); and the lateral parts bear the palpi. These latter organs (fig. 7) consist of one long and three succeeding shorter joints. The long joint contains a muscle which acts upon the remaining joints. The whole organ is kept in its place adpressed to the tongue by a muscle which arises from the walls of the mentum (*p*).

The maxilla (fig. 9) consists of a stipe and a blade. When the maxillæ are closed together, they cover the tongue on the upper or forward side, and, together with the labial palpi, completely surround it. When folded back the blades carry with them the tongue and palpi; the lower edge of the blade fits into the space between the base of the maxilla and the mentum, and thus the whole apparatus is neatly tucked away and safely protected. The lower side of the blade is plaited at its anterior end (fig. 14), the extreme edge is fringed with hairs (*d*), and between these hairs are smaller hairs or bristles (*b* and *c*) seated on papillæ; alternately a shorter and weaker hair on a longer papilla and a longer and stouter hair on a shorter papilla. There is nothing in the appearance of the end to support the assertion frequently made, that it is used for cutting purposes. The harder the chitine, the darker it is; but the end of the blade is very transparent and delicate.

The movements of the organs before mentioned are controlled by the following muscles. A pair of muscles ($ex\,m^1$, figs. 2 & 5) which spring from the outer base of the cranial pillar (*a*) are inserted into the end of the cardo (*d*), together with a second pair, which spring from the back wall of the head, $ex\,m^2$. The contraction of these moves the cardo on the fulcrum formed at its juncture with the walls of the oral chamber, and consequently carries forward the lower end and the parts attached thereto; that is, the whole mentum and the maxillæ. The posterior end of the maxilla is brought forward by the muscle mx^1 (fig. 4, lower portion of longitudinal section of head, showing muscle; and fig. 5), and this muscle is opposed by the muscles mx^2 and mx^3. The lateral movements of the maxilla are produced by the action of a muscle found in its base (mx^4, fig. 5), which is inserted into the end of a dark chitinous strap (*j*, figs. 4, 5, & 6). This strap is hinged at one end to the side of the inner oral chamber at *h* (figs. 5 & 6). The contraction of mx^4 results therefore in drawing aside the whole organ, the elasticity of the hinge being sufficient to restore it again. The blade of the maxilla is extended by the muscle mx^5 and flexed by mx^6 (fig. 5).

The general appearance of the tongue is that of a slightly tapering brush-like organ densely covered with long hairs, which, when extended, is longer than the palpi. Within this, however, is a hyaline rod, which, arising from the central part of the end of the mentum (*l*, fig. 15, also fig. 8, longitudinal section of mentum, with tongue extended; fig. 9, the same, with tongue contracted; and fig. 10, section of tongue, A, taken near the root B, taken about halfway down). This rod terminates in a bifurcation upon a small ladle-shaped organ at the extremity of the tongue (*l*, A and D, fig. 11). The outer wall of the tongue is attached to it directly only at the anterior end. In section it will be seen that the side of the rod turned towards the bee is channelled by a groove which runs through its entire length. The outer wall of the tongue is not tubular, but is open along the back; the edges of this slit are united to each side of the rod by means of very thin expansions of membrane (m, fig. 10), one side of which is covered by hairs; the hairs at the anterior end are very short and are seated on irregular papillæ (fig. 18), whilst those at the posterior end arise from regular pointed papillæ and are somewhat longer (fig. 16, from above, fig. 17, from the side). The existence of this membrane may be easily demonstrated if the entire head of a recently killed bee with the tongue extended be placed in an ordinary live-box and be subjected to pressure. The rod, which is naturally curved, being pressed in the middle and being supported at both ends, is forced out of its place, and brings with it the membrane in question. Professor A. J. Cook, of Michigan, appears to think that the bee when feeding brings the rod to the outside and so increases the internal dimensions of the tongue by adding that of the second chamber formed by the membrane; and this opinion is shared by Mr. J. Spalding (Amer. Nat. Feb. 1881, p. 113), both authors giving illustrations in explanation. After many observations of bees when feeding, some made with the microscope, I cannot agree with this view; certainly it is not their invariable way of feeding, and, in fact, I have never seen any bee feed in this way.

The hairs covering the surface of the tongue are long and finely pointed, with flattened bases, and are arranged in regular whorls (fig. 15). The hairs near the base of the tongue are much shorter and broader, and are sometimes split into two or three points. Interspersed among these hairs are a number of bristles which occur on every fifth whorl. These bristles are similar in character with those found on the edge of the maxillæ, on the end joints of the palpi, and on the extremity of the tubular portion of the tongue itself. They all follow one type, viz. that of a bristle arising from the summit of a papilla. I am inclined to consider that they are touch-organs, and nothing more. It must be borne in mind that, covered with a hard skin, as all insects are, their nerves can hardly be susceptible to external influences to any great extent. These soft parts in their harness supply this deficiency. Then, it may be urged, why not consider those on the tongue as organs of taste? The answer is, that on two occasions, when desirous of making bees feed on coloured honey (one bee being under chloroform, and the other torpid through cold), no motion was produced in the tongue when honey was brought in contact with it. I do not presume to say the bee did not taste it, but it made no outward and visible sign that it did. Immediately, however, I moved the honey and touched the antennæ of these same bees with the same honey, the usual movements of the tongue were produced, although there was then no honey touching the tongue. I cannot therefore suppose that these bristles in the region of and on the tongue are taste-organs.

On the outer surface of the base of the tongue is a smooth groove (*n*, figs. 8 & 24, base of tongue, from above); this is only found in the workers. When bees feed one another, the tongue of the bee that is taking the food is applied to this groove on the tongue of that which is supplying it. The importance of it being free from hair is clear when it is remembered that an extension and contraction of the tongue is, except in one condition, the invariable mode in which the bee obtains its food; it would obviously be impossible for the tongue, thickly covered with hairs as it is, to pass over another surface as thickly covered, more especially when the hairs are in each case directly opposed to one another.

The posterior end of this feeding-groove is hinged to a lever (*o*, figs. 6, 8, & 9), the shape and position of which can best be understood from a reference to the figure. From the centre of the lower part of this lever arise two chitinous processes—one dark, curving forward, and uniting with the paraglossæ (*p*, fig. 8); the other hyaline, which, passing upwards, forms one side of the lower part of the salivary valve (*q*, fig. 8). To the lower end of the lever is affixed the muscle T; the contraction of this muscle will act upon the lower chitinous process running to the salivary valve, and serve to close it. The salivary valve just referred to is semicircular in transverse section (*t*, fig. 23); and, when viewed from above, is irregularly oblong (*t*, fig. 22). A pair of muscles (s^1, figs. 8 & 9) act upon it from below, and two other pairs (s^2 and s^3, figs. 6, 8, & 9). At the posterior end it receives the salivary duct (*r*, figs. 3, 6, 8, & 9). This duct arises in the thorax, and, after there collecting the saliva, receives the products of the glands, found on each side of the head, and then passes into the mentum.

The tongue and paraglossæ, but not the palpi, are partially withdrawn into the mentum, in the manner shown in fig. 9, by the action of a pair of muscles (*r.t.* figs. 2, 3, 4, 6, 7, 8, & 9); they arise from the upper and hinder part of the head, and are inserted at the upper part of the paraglossæ.

In that part of the mentum surrounding the salivary valve is the chamber in which the syrup or nectar comes in contact with the saliva, and from which it passes upwards to the pharynx. This chamber is almost obliterated when the tongue is retracted and drawn within the mentum; while, on the other hand, on the protrusion of the tongue its capacity is considerably increased. This can be more readily understood by reference to the diagrams figs. 25 and 26, the asterisk (*) being the chamber.

Before considering the action of the tongue, a reference must be made to the ladle-shaped organ found at the tip of the tongue (fig. 12, from above, fig. 13, end on, and fig. 14, side view). Mr. Hyatt describes and figures it as a hollow cone or funnel which serves as a sucking-disk (Amer. Q. Mic. Journal, 1879, vol. i. p. 287). Others have spoken of and regarded it as a button. Upon the concave surface of this ladle-shaped organ are a number of curious hairs, shown at fig. 15; they are branched and divided in the manner shown, with the hairs turned inwards.

The true nature and function of the tongue has been the subject of discussion from very early times. Mr. Chambers, in the 'Journal of the Cincinnati Society of Natural History' (April 1878), summarizes the various views entertained at different times. It will be necessary briefly to refer to some of these theories. Kirby and Spence (Introd. vol. ii. p. 177) say the tongue, "though so long and sometimes so inflated, is not a tube through which honey passes, nor a pump acting by suction, but a real tongue, which laps or licks the honey and passes it down on its upper surface, as we do, to the mouth." Huxley follows this, and says, "Functionally this organ is a tongue, and enables the bee to lap up the honey on which it feeds." Newport goes more into detail, and says:—"It is not tubular, but solid ... the manner in which the honey is obtained when the organ is plunged into it at the bottom of a flower is by lapping, or a constant succession of short and quick extensions and contractions of the organ, which occasions the fluid to be accumulated upon it and ascend along its upper surface until it reaches the orifice of the tube formed by the approximation of the maxillæ above and the labial palpi and this part of the ligula below... At each contraction a part of the extended ligula is drawn within the orifice of the tube, and the honey with which it is covered ascends into the cavity of the mouth, assisted in its removal from the surface of the ligula by the little bunch of hairs with which the elongated second joint of each labial palpus is furnished." I have quoted this at length, as it is substantially the same as that given by Hermann Müller in 'Nature,' vol. viii. p. 189.

If a bee be put to a large drop of honey, it will be found to open slightly the whole of the organs of the tongue, and with a scarcely perceptible motion suck in honey, no doubt by means of, or largely assisted by, the muscular pharynx (*s*, figs. 3 & 4). Flowers, however, do not ordinarily contain nectar in such abundance nor in such convenient positions. The nectaries are described as usually only a small spot, which, without becoming more prominent, produces the nectar; but frequently they are in the form of a glandular protuberance, or project in the form of cushions, or, again, as shallow excavations (Sachs' 'Text-book,' 2nd ed. 1882, pp. 494–569).

In order to obtain the conditions more nearly approaching those in nature therefore, the honey should be presented smeared thinly on a bit of glass. If this be done, the bees will clear off every trace of honey, and leave the glass as clean as it was before the honey was smeared on it. This is done by the bee applying the lower and outer portion of the tongue to the surface of the glass, in the manner shown in diagram, figs. 25 & 26. The long joints of the labial palpi just touch the glass, the shorter joints being bent outwards at right angles. The tongue is then extended and retracted with great regularity and some speed, and to me it appears that the extension is a somewhat slower movement than the retraction. When the tongue is in this position the "ladle" will be turned with its concave side downwards, and that surface of the tongue which is split will be upwards. The pressure on the surface of the glass will move the rod to the opposite side of the tubular portion of the tongue in that part of it which is being pressed against the glass. This will cause the two membranes (*m*) to form a trough, which will of course be opened on its upper surface; and, although I have not actually observed the fact, it seems impossible to suppose that the honey does not pass into this trough. As the tongue is being retracted, the rod which was pressed against the inner side of the tongue will pass over to the front side, and so considerably enlarge the trough made by the membranes in the upper portion of the tongue, and the edges of the slit in the outer wall being closely united by interlocking hairs, the result will be the creation of a vacuum which will draw up the honey from the lower portion of the tongue. The tongue is then again extended; but now the salivary chamber is enlarging as the tongue is protruded, and the honey is so carried up still higher and into the mouth, whence it is once more drawn up by the muscular pharynx.

This, however, will not account for the bee being able to remove such minute traces of honey as it undoubtedly can. The hairs of the tongue will sweep backward the honey, that is to say, will drive it away from the mouth, towards the end of the tongue itself, and the ladle-shaped organ will then serve, as the tongue is being withdrawn, to collect and drive into the tongue the honey thus collected. When within the tongue, the capillarity of the narrow groove, assisted by the action of the salivary chamber, will afford a means, which the larger opening would not afford, of the smallest particle of honey being sucked up.

Professor Cook, in a paper reported in the Amer. Bee Journal, Nov. 1879, gives the following account of some experiments which support this view. He says:—"I have placed honey in fine tubes and behind fine wire gauze, so that bees could just reach it with the funnel [the ladle-shaped organ] at the end of the rod. So long as they could reach it with the funnel, so long would it disappear. I have in such cases seen the red axis when the bee was sipping coloured syrup. Subsequent examination by dissection revealed the red liquid still in the tube of the rod."

Bees always apply the forward and lower side of the tongue to the honey, even when it is put into a position in which almost any other way would appear more convenient.

The statement which has found its way into so many books that bees obtain the honey by lapping*, appears to me to be without foundation. The length and direction of the hairs, *i. e.* all pointing away from the bee, is sufficient to condemn it.

The next theory,—that propounded by Hermann Müller,—is as follows:—"The terminal whorls of hairs are filled with honey by adhesion; this honey is withdrawn into the sheath of the tongue [formed by the meeting of the maxillæ and the palpi], and is driven towards the œsophagus by a double cause: first by the pressure of the erect whorls of hairs, and secondly by suction." He elsewhere says the whorls of hairs are erected rhythmically, and that the suction here referred to is due to the action of the stomach. I cannot, however, accept this explanation, for (1) there does not appear to me to be any reason for supposing the hairs of the tongue are capable of being voluntarily erected; (2) the tapering shape of the tongue and the direction and length

* "Functionally this organ is a tongue and enables the bee to lap up the honey on which it feeds" (Huxley's 'Manual of Invertebrata' p. 428). See also John Hunter, in Enc. Brit. 1875, "Bees;" Shuckard, 'British Bees,' 1866, p. 37 *et seq.*

of the hair seem opposed to the idea that its withdrawal in the tubular surroundings would drive the honey towards the head; (3) the dense covering of hair seems to make such a mode of action impossible; (4) it does not account for the organs inside the tongue nor for the ladle-shaped appendage before referred to.

Shuckard, in his 'British Bees' (p. 37), although he holds to the lapping theory, says that if a bee be observed whilst sipping any sweet liquid, the anterior portion of the tongue will be sometimes seen more swollen than when [? not] in action, and alterations will be observed in it of varying expansions. At another place he says the bee is also seen to curve the tongue about, causing from time to time the superior surface to become concave, to give, as it were, to the liquid with which it is loaded a downward inclination towards the head. The extremity is frequently above the surface of the liquid, and again the tongue can swell and contract; "these swellings and constrictions are observed to succeed each other."

These observations seem to me to support the theory I have here ventured to propound, namely, that the honey is drawn into the mouth through the inside of the tongue by means of a complicated pumping action of the tongue itself and its closely contiguous parts, and not in any sense by lapping.

DESCRIPTION OF THE PLATES.

Plate XVIII.

Fig. 1. Longitudinal section through head of Bee, without muscles. *a*, Chitinous pillar supporting the front of the head; *b*, second pillar, from the side of which arises the thin chitinous wall *c*; *d*, cardo; *f*, base of maxilla.

2. Transverse section through same. *a*, *b*, and *d* as before; *Ex m* and *Ex* m^2, muscles inserted into the head of cardo; *rt*, retractor of tongue.

3. Longitudinal section through head, with muscles. *h*, Thin wall of the upper side of mouth-cavity; *r*, salivary duct; *rt* as in fig. 2; *s*, pharynx; *g*, mentum; *e*, lora.

4. Longitudinal section through anterior end of head, with muscles. *a*, Portion of chitinous pillar as in fig. 1; *h*, *s*, and *rt* as in fig. 3; *j*, chitinous strap divaricating the maxillæ; *f*, base of maxilla; mx^1, mx^2, and mx^3 respectively, muscles of the maxilla.

5. Enlarged figure of the base of maxilla and adjacent parts. *d*, Cardo; *e*, lora; *f*, basal joint; *g*, mentum; *h* as in fig. 3; *j* as in fig. 4; mx^1, mx^2, mx^3, ends of muscles mx^1, mx^2, and mx^3 of fig. 4; mx^4, muscle lying behind *j*, which draws the maxilla outwards: mx^5, extensor of blade of maxilla, mx^6; mx^7.

6. Tongue of Queen Bee and adjacent parts, from above. *d*, Section through cardo; *e*, *f*, *g*, *j*, as before; *h*, section through thin wall of mouth-cavity, as in figs. 3 and 4; *o*, lever at root of tongue from above; *r*, salivary gland; *rt*, retractor of tongue; s^2, muscles inserted into sides of the outer wall of salivary valve; s^3, muscles inserted into the centre of same.

Fig. 7. Palpus, with portion of mentum, *q*, attached. *h*, Wall of mouth-cavity, as before; *k*, forward side of paraglossum; *p*, muscle inserted into paraglossum, and withdrawing same; *rt.* as before.

PLATE XIX.

8. Section through base of tongue and mentum, extended. *g*, Mentum; *e*, lora; *l*, hyaline rod of tongue; *n*, feeding groove; *t*, salivary valve; *o*, lever of tongue, as in fig. 6, side view; *p*, paraglossum; *q*, ridge from posterior side of salivary valve, united with lever *o*; s^1, muscle acting on posterior side of valve; s^2 and s^3 as before; *to.* muscle inserted into foot of lever *o*, and throwing same forward.
9. The same, retracted.

Fig. 10. Transverse section through tongue near base. *l*, Hyaline rod; *m*, membranous bag; *n*, feeding groove.
11. The same, towards the end.
12. Ladle-like organ at end of tongue, sometimes called the "button." *l*, Hyaline rod of tongue, showing bifurcation.
13. The same, end view.
14. The same, side view.
15. Branched hairs on same.
16. Hairs on the inside of membranous bag, *m*, of figs. 10 and 11, from above, showing ridges of papillæ upon which they stand.
17. Side view of same.
18. Side view of same near the anterior end, showing irregularly shaped papillæ.
19. Hairs on surface of tongue with expanded bases. *b*, Sensory bristles scattered through same.
20. The same, from base of tongue.
21. Portion of blade of maxillæ. *aa*, Plications; *bb*, sensory bristles, the longer ones on shorter pillars; *cc*, the same, the shorter ones on longer pillars; *d*, longer hairs of same.
22. Anterior end of mentum (without muscles), showing salivary valve; *l*, Base of hyaline rod springing from chitinous tongue.
23. Transverse section of same.
24. Posterior end of tongue, showing feeding groove, *n*.

25 & 26. Diagrammatic view of tongue when feeding. *t*, valve. Fig. 25 is the position of tongue and internal parts as it arrives at the termination of the extension motion. Fig. 26, The same, at the termination of the retraction motion.

On a new Genus of Recent Fungida, Family Funginæ, Ed. & H., allied to the genus *Micrabacia*, Ed. & H. By Prof. P. MARTIN DUNCAN, F.R.S., Vice-Pres. Linnean Society.

[Read 5th June, 1884.]

(PLATE XX.)

Genus DIAFUNGIA, genus nov.

Corallum discoid, free, without trace of adhesion, not quite circular in outline, much broader than high. Base with a primary triangular piece extending beyond the centre, slightly projecting downwards, the rest of the coral grouping from its sides and apex, so that there is an appearance of former fracture and subsequent mending. Calice unsymmetrical from the prolongation of the larger septa of the primary piece beyond the centre, and from the radiation of septa from the sides and apex of the primary piece to the edge of the disk or the margin.

Columella absent. Septa numerous, order confused; many join others near to and remote from the margin. Larger septa exsert, arched near the margin, from which they rise perpendicularly, and low near the septa of the primary piece. Septa dentate and strongly granular near their free edge, solid and stout.

Costæ broad, unequal, often bifurcating, variously directed. At the margin each costa gives off a branch on either side to form a septum with the corresponding offshoot of the next costa. Hence the septa correspond with the intercostal spaces. Intercostal spaces regularly furnished with equidistant synapticula, presenting a regularly perforated appearance. Synapticula discontinuous, strongly developed between the septa, some reaching high up in the interseptal loculi. There is no true wall, the septo-costal structure being united by synapticula alone.

Species 1. Diafungia granulata. (Plate XX.)

Corallum low, three times as broad as high. Primary piece large and very distinct, with eight large costæ and septa and some offshoots. Septa without definite order, sixty in number, those of the primary piece the longest. Many septa unite and are slightly granular low down, but very granulate at the dentate edge; they are exsert near the margin, often wavy. Synapticula large and unequal. Costæ very regular, some small ones come off from the subequal large ones. The costæ of the primary piece the largest. On the larger costæ there is a straight continuous row of minute granules, on either side close to the edge of the intercostal space, and between the rows a row of larger granules. Sometimes this last is not seen, and in the smaller costæ it is usually wanting. Intercostal spaces well developed. Synapticula sunken, subequal, numerous, perforations very symmetrically disposed. Derivation of a septum from two costæ very distinct. Length 6 millim. and 4·5 millim.; height 1·75 millim. and 1·5 millim.

Locality. Corean Sea, shallow water.

The "primary piece" of this species was evidently the original coral, and the surrounding portions grew subsequently. This apparently broken and mended aspect is exactly like what is seen in most specimens of species of *Diaseris*. But the regularly perforated wall, and the curious forking of the costæ at the origin of the septa around the margin, distinguish the genera.

Were there symmetrical growth, and did the costæ radiate from a common centre, the form would come within the genus *Micrabacia* (Edwards and Haime, Hist. Nat. des Corall. vol. iii. p. 30, 1860). The genus is therefore a very interesting addition to the family Funginæ, and must be placed between the genera *Fungia* and *Micrabacia*.

It is mimetic of the genus *Diaseris* of the Lophoserinæ.

EXPLANATION OF PLATE XX.

Fig. 1. *Diafungia granulata.*—Base of corallum, natural size.
Fig. 2. The base, magnified.
Fig. 3. Costæ, magnified, showing granules and synapticula.
Fig. 4. Costæ, magnified (3 rows of granules).
Fig. 5. Same, more magnified.
Fig. 6. Costæ bifurcating into septa, magnified.
Fig. 7. Septa and synapticula, magnified.
Fig. 8. Margins of a septum, magnified.
Fig. 9. Oblique view of interseptal spaces, and septa and synapticula.

Notes on a Collection of Birds made by Herr F. Bohndorff in the Bahr el Ghazal Province and the Nyam-nyam Country in Equatorial Africa. By R. Bowdler Sharpe, F.L.S., F.Z.S., Senior Assistant, Department of Zoology, British Museum.

[Read 1st May, 1884.]

I owe the opportunity of examining the interesting collection described in the present paper to the kindness of Mr. Bohndorff, who has just returned to Europe, after a hazardous passage down the Nile and across the desert of Korusko to Cairo. Mr. Bohndorff has been collecting in Africa for the last ten years, but has had the bad fortune to lose most of the results of his labours, his largest collection, the outcome of two years' toil, having been utterly destroyed when he fell into the hands of Zebehr's son, Suleiman, and the rebel troops at the time when General Gordon went out to Equatorial Africa as Governor-General of the Soudan for the first time. Stripped of everything he possessed and barely escaping with his life, which he owed to the intervention of an Egyptian officer, Achmed Effendi void el Chéter, who concealed him in the guise of a female slave in his house until the departure of the rebel soldiery, Mr. Bohndorff arrived at Chaka, where he met our gallant countryman General Gordon, who at that moment arrived to destroy the town, which was in league with Suleiman and the rebels. The General generously provided the ruined traveller with clothes, camels, and money to enable him to return to Cairo. After an absence of many years from Europe, Mr. Bohndorff was anxious to return to his home in Mecklenburg; but on arriving at Cairo, he found that Dr. Junker, the well-known Russian traveller, was about to project an expedition into Central Africa, and, acting upon the solicitations of Dr. Schweinfurth and other friends, Mr. Bohndorff agreed to accompany Dr. Junker back to Equatorial Africa. The journey which he undertook, in company with the last-named explorer, is shown in the map of Central Africa by Dr. Joseph Chevanne.

While Dr. Junker was pushing his way still further to the westward in his explorations of the Welle River, Mr. Bohndorff stayed for two years at Dem Suleiman, the capital of the Gazelle River Province, with our countryman Lupton Bey, its governor, and made part of the collections here described. On receiving notice of the danger which threatened the route to Khartoum by the spread of the Mahdi's insurrection, he despatched a messenger to Dr. Junker, urging him to join him in his retreat down the Nile. Dr. Junker, however, preferred to remain along with his large collections. Thereupon Mr. Bohndorff, accompanied by his faithful negro servant "Yumma" (who is present with him this evening), ran the gauntlet of the rebels in a Nile steamer, and, after being twice attacked by the Arabs, arrived in safety at Khartoum. There he stayed a few days with our beleaguered countrymen, Colonel Coetlogon and Mr. Power, and occupied the room of the unfortunate General Hicks. He arrived in safety at Berber; and afterwards in the midst of the Korusko desert he perceived an approaching cavalcade, which proved to be General Gordon and Colonel Stewart with a small following, going post-haste to Khartoum. This was in last February, and the surprise was mutual; but one can well imagine the delight with which Mr. Bohndorff tells us he recognized his friend and preserver. Ten years before, when General Gordon was in Cairo, on his way to the interior as Governor of the Bhar el Ghazal Province, he met Mr. Bohndorff, then a young man anxious to explore Equatorial Africa, and took him with him. Mr. Bohndorff was with the General on several of his expeditions for the suppression of the slave trade, when Gondokoro was destroyed and Lado founded as a capital town; while for a short period he was installed as Gordon's lieutenant at Sobat. A considerable amount of interest, therefore, attaches to the meeting of these old friends in the midst of the desert of Korusko.

On looking over the present collection, we are at once struck by the presence of so many species hitherto believed to be peculiar to West Africa; but it will be noticed that these species are from the Nyam-nyam district and from Semmio's country, while those from the Gazelle River are many of them well-known inhabitants of North-eastern Africa and Senegambia. It is evident that Mr. Bohndorff, when he crossed the watershed and descended into the Nyam-nyam country, passed the boundary line of two faunas, and that the animals of the Nyam-nyam country are those of the Gaboon and the Congo rather than those of the Lado district or of Kordofan. He informs me that the character of the countries are different; in Semmio and Ndoruma the forests clothe the sides of the rivers as in the countries of Western Africa, while in the Bahr el Ghazal the sides of the rivers are covered with grassy country, with occasional clumps of forest.

I have followed in the present paper the classification adopted by Dr. Hartlaub in his memoirs on Emin Bey's collections from Equatorial Africa, as it is in connexion with the recent explorations of the latter traveller that Mr. Bohndorff's collections possess the greatest amount of interest. I subjoin a list of the localities whence the specimens are recorded.

In the Nyam-nyam country, Sassa, Semmio, and Ndoruma are marked on the map above referred to. Mangbanga, an affluent of the Welle River, is not put down in any map at present.

Dembakir (26° W. long.) is on the slope of the watershed between the Gazelle-River Province and the Nyam-nyam country. Jur or Djur, Gattas, and Muschra-rec, the port of the Gazelle River, are marked in several maps.

Dem Suleiman, or Dem Zebehr, is the Moudirieh or capital of the provinces of Bahr el Ghazal and Nyam-nyam. It is the residence of Lupton Bey, and is called by the negroes "Juku."

In the following paper I have referred principally to the great work by Von Heuglin, the 'Ornithologie Nord-ost Afrikas,' and also to the two papers by Dr. Hartlaub:—

1. "Beitrag zur Ornithologie des Oestlich-Aequatoriälen Gebiets Africas. Nach Sendungen und Noten von Dr. Emin Bey in

Lado." Abhandl. Nat. Ver. Bremen, Bd. vii. Heft 2, pp. 83–128, Taf. v.

2. "Zweiter Beitrag," &c. *Op. cit.*, Bd. viii. Heft 1, pp. 183–232, Taf. v.

Ordo I. *OSCINES.*

Series II. LAMINIPLANTARES.

Cohors I. Cichlomorphæ.

Phalanx 2. *Brevipennes.*

Fam. Crateropodinæ.

1. Crateropus Bohndorffi, sp. n.

Sassa, November. Iris brown.

Captain Shelley has given a revision of the species of *Crateropus* in the 'Ibis' for the present year (pp. 46–48), with a "Key to the species" improving on that given in my 'Catalogue' (vol. vii. pp. 469–470). In both our arrangements, however, the present bird finds itself in the yellow-billed section of the genus, in the neighbourhood of *C. atripennis* and *C. Haynesii*, which species it resembles in its maroon-coloured under surface. It may be placed in the "Key" as follows:—

d'. Abdomen maroon-brown.
  g''. Head pearly grey.
    i'''. Throat and fore neck pearly grey .... *atripennis.*
    k'''. Throat and fore neck maroon like the rest of the under surface .... *Hohndorffii.*
  h''. Head black .... *Baynesii.*

The following is a description of the type:—

Adult. General colour above maroon from the nape to the tail-coverts, which are like the back; wing-coverts and primary-coverts dark ashy, edged with dull maroon; quills blackish, the primaries dull rufous towards the ends, the secondaries blackish, externally dull maroon; tail-feathers black, externally washed with dull maroon; crown of head and nape pearly grey, with lighter tips to the frontal feathers; lores, feathers below the eye, and a ring round the latter black; ear-coverts and hinder part of cheeks pearly grey; fore part of cheeks black; entire under surface of body dark maroon, the chin black; under wing-coverts like the breast; quills dusky below, slightly rufescent along the edge of the inner web. Total length 8·5 inches, culmen 0·85, wing 4·2, tail 3·1, tarsus 1·35.

Fam. MALACONOTINÆ.

2. LANIARIUS GAMBENSIS (*Licht.*).—Dryoscopus gambensis, *Heugl. Orn. N.O. Afr.* i. p. 456; *Hartl. Abhandl. Nat. Ver. Bremen*, vii. p. 93; *Gadow, Cat. B. Brit. Mus.* viii. p. 146.

Dem Suleiman, November. Iris red.

3. LANIARIUS ÆTHIOPICUS (*Gm.*).—Dryoscopus æthiopicus, *Heugl. t. c.* p. 458; *Gadow, Cat. B.* viii. p. 139.

Two adult birds from Semmio, January. Iris blackish brown.

4. LANIARIUS POLIOCEPHALUS (*Licht.*); *Gadow, Cat. B.* viii. p. 156.—Meristes poliocephalus, *Heugl. t. c.* p. 466; *Hartl. Abhandl. Bremen*, viii. p. 193.

A large series of adult specimens from Semmio, August. Iris orange-yellow.

They all bear out Von Heuglin's remark that the specimens from North-eastern Africa show no orange tint on the breast.

5. LANIARIUS ERYTHROGASTER (*Cretzschm.*); *Hartl. op. cit.* vii. p. 94; *Gadow, t. c.* p. 154.—Dryoscopus erythrogaster, *Heugl. t. c.* p. 463.

Two adult males from Jur Gattas, November. Iris clear yellow.

6. LANIARIUS CHLORIS (*Licht.*).—Nicator chloris, *Gadow, t. c.* p. 166.

An adult bird from Ndoruma, November. Iris greenish brown.

Exactly similar to the series in the British Museum from Fantee and Gaboon.

Phalanx 3. *Æquiparatæ.*

Fam. PACHYCEPHALINÆ.

7. BRADYORNIS DIABOLICUS, *Sharpe, Cat. B.* iii. p. 314.

An adult from Dem Suleiman, killed in November.

On reviewing the question of this species and *B. ater*, I cannot determine whether the former name should be suppressed or retained. I still think that there are two species; but the material for determining the point is insufficient, nor can I yet attach to the bird an older name than that given in my 'Catalogue' (*l. c.*), as long as it cannot be proved to be the *Sylvia pammelæna* of Stanley, which is in all probability *Melænornis edoloides.*

Fam. Laniinæ.

8. Lanius excubitorius, *Des Murs*; *Heugl. t. c.* p. 478; *Hartl. op. cit.* vii. p. 96; *Gadow, t. c.* p. 253.

A fine adult female from Jur Gattas, November. Iris blackish brown.

9. Corvinella corvina, *Shaw*; *Gadow, t. c.* p. 231.—C. affinis, *Heugl. t. c.* p. 488; *Hartl. op. cit.* vii. p. 96.

An adult bird from Dem Suleiman, May.

Phalanx 4. *Brachypodes.*

Fam. Pycnonotinæ.

10. Xenocichla indicator (*Verr.*); *Sharpe, Cat. B.* vi. p. 103.

One specimen from Mangbanga, April. Identical with West-African examples in the Museum.

11. Andropadus virens, *Cass.*; *Sharpe, Cat. B.* vi. p. 109.

Two specimens from Sassa, procured in October and November. Not to be distinguished from West-African skins.

Fam. Oriolinæ.

12. Oriolus auratus, *Vieill.*; *Heugl. t. c.* p. 401; *Sharpe, op. cit.* iii. p. 195; *Hartl. Abhandl. Bremen*, viii. p. 195.

Several specimens from Sassa, all of them identical with others from Senegambia in the British Museum.

13. Oriolus nigripennis, *Verr.*; *Sharpe, Cat. B.* iii. p. 220.

A single specimen from Sassa, November. Identical with Gaboon birds in the Museum.

Fam. Campephaginæ.

14. Graucalus pectoralis, *J. & S.*; *Sharpe, Cat. B.* iv. p. 29.—Ceblepyris pectoralis, *Heugl. t. c.* p. 418.

A male from Dem Suleiman, May; and a female from Sassa, October. Mr. Bohndorff says that it is a common bird in Nyam-nyam.

15. Campephaga xanthornoides (*Less.*); *Sharpe, Cat. B.* iv. p. 60.

A female bird from Ndoruma, November, appears to belong to the present species.

Family Prionopinæ.

16. Sigmodus mentalis, sp. n.

From Sassa, October. Having compared Mr. Bohndorff's specimens with *S. rufiventris* in the British Museum from Gaboon, I find that the former may always be distinguished by the smaller grey spot on the chin. It is strictly confined to the base of the latter, whereas in *S. rufiventris* the grey spot on the throat is much more extended, occupying the whole chin and part of the upper throat as well.

Adult. General colour above black with a greenish gloss; wing-coverts like the back; quills black, externally greenish black like the back; tail black with a greenish gloss, and ribbed with dusky cross-bars under certain lights; round the hind neck a black collar, uniting with the black throat; entire head and nape blue-grey, pearly grey or white on the lores and round the eye; cheeks, ear-coverts, and base of chin blue-grey; remainder of chin, throat, and sides of neck black; fore neck and chest white; remainder of under surface pale cinnamon-brown; sides of upper breast, axillaries, and under wing-coverts greenish black; quills below black, all but the first primary and the inner secondaries with a large white spot on the inner web. Total length 8·3 inches, culmen 0·85, wing 4·55, tail 3·2, tarsus 0·85.

Fam. Dicrurinæ.

17. Buchanga assimilis (*Bechst.*); *Sharpe, Cat. B.* iii. p. 248. —Dicrurus divaricatus (*Licht.*); *Heugl. t. c.* p. 422; *Hartl. op. cit.* vii. p. 97.

Several specimens from Kutschugali.

Phalanx 5. *Latirostres.*

Fam. Platystirinæ.

18. Pachyprora orientalis (*Heugl.*).—Platystira orientalis, *Heugl. t. c.* p. 449.—Batis orientalis, *Sharpe, Cat. B.* iv. p. 136.

An adult male from Omschanga in Darfur, January.

Fam. Muscipetinæ.

19. Terpsiphone cristata (*Gm.*); *Sharpe, Cat. B.* iv. p. 355. —Tchitrea melanogastra, *Hartl. op. cit.* p. vii. p. 17, viii. p. 197. —Terpsiphone melanogastra, *Heugl. t. c.* p. 441.

A series of male birds from Semmio, March. One is a perfectly adult bird, agreeing with the fine specimen from Old Calabar with white under tail-coverts, mentioned by me in the 'Catalogue' (*l. c.*).

Fam. Dendrœcinæ.

20. Zosterops senegalensis, *Bp.*; *Heugl. t. c.* p. 414; *Hartl. op. cit.* vii. p. 99; *Sharpe, Cat. B.* ix. p. 181.

An adult male from Dem Suleiman, November.

Cohors II. Conirostres.

Phalanx 1. *Decempennatæ.*

Fam. Ploceinæ.

21. Malimbus nitens (*J. E. Gray*); *Elliot, Ibis*, 1876, p. 463.

An adult bird from Ndoruma, November. Iris dark red; bill ashy grey.

The range of this species, as given by Mr. Elliot, was from Sierra Leone to the Congo. DuChaillu found it in Gaboon. The present record is therefore of the greatest interest.

22. Hyphantornis atrogularis, *Heugl. Orn. N. O. Afr.* i. p. 559, pl. 19.

An adult male from Sassa, in September.

It is identical with Mr. Forbes's Lokoja specimen (Shelley, Ibis, 1883, p. 550).

Fam. Viduinæ.

23. Vidua principalis (*L.*); *Heugl. t. c.* p. 585; *Hartl. op. cit.* vii. p. 102.

A male from Sassa, in September.

24. Penthetria macrura (*Gm.*); *Heugl. Orn. N. O. Afr.* i. p. 579; *Hartl. op. cit.* viii. p. 202.

An adult male from Ndoruma, August.

Cohors III. Coliomorphæ.

Phalanx 2. *Humilinares.*

Fam. Sturninæ.

25. Lamprocolius splendidus (*Vieill.*); *Hartl. Orn. Westafr.* p. 117.

A large series from Kutschugali and Semmio. Iris yellowish white.

Identical with Gaboon examples.

26. LAMPROCOLIUS AURATUS (*Gm.*); *Hartl. t. c.* p. 117.

A large series from Kutschugali and Semmio. Dr. Hartlaub considers the birds collected by Dr. Emin Bey at Fatico to be referable to *L. amethystinus* of Heuglin, distinguished from West-African *L. auratus* by the purplish-violet colour of the underparts, instead of the latter being steel-blue with a violet lustre. Mr. Bohndorff's specimens agreed with the Fantee birds.

27. ONYCOGNATHUS HARTLAUBI, *Gray, P. Z. S.* 1858, p. 291.

Several specimens of both sexes killed in Semmio in March. "Iris red."

Identical with specimens from Fantee. This occurrence of a typical West-African genus so far eastwards is interesting.

28. PHOLIDAUGES LEUCOGASTER (*Gm.*); *Heugl. t. c.* p. 521; *Hartl. op. cit.* viii. p. 227.

Apparently rare, as very few specimens were in the collection. A male was procured at Sassa in November, and a female in Semmio in May.

Phalanx 3. *Altinares.*

Fam. GARRULINÆ.

29. CRYPTORHINA AFRA (*L.*); *Sharpe, Cat. B.* iii. p. 75.—Ptilostomus senegalensis, *Heugl. t. c.* p. 491; *Hartl. op. cit.* vii. p. 107.

A large series of both sexes from Kutschugali and Semmio.

Phalanx 4. *Idiodactyles.*

Fam. IRRISORINÆ.

30. IRRISOR ERYTHRORHYNCHUS (*Lath.*); *Heugl. Orn. N.O.-Afr.* i. p. 214; *Hartl. op. cit.* vii. p. 107.

A specimen from Kutschugali.

Cohors V. CINNYRIMORPHÆ.

Fam. NECTARINIINÆ.

31. NECTARINIA PLATYURA (*Vieill.*); *Heugl. Orn. N.O.-Afr.* i. p. 225; *Gadow, Cat. B. Brit. Mus.* ix. p. 10; *Hartl. op. cit.* vii. p. 109.—Hedydipna platyura, *Shelley, Monogr. Nect.* p. 7, pl. 3.

An adult male from Dem Suleiman, November. It agrees perfectly with Senegambian skins, and has a narrow violet line separating the green throat from the abdomen, not to the same extent as in its ally, *N. metallica*, but still sufficiently distinct to make me wonder that neither Capt. Shelley nor Dr. Gadow has noticed it. The latter gentleman, although he quotes Von Heuglin's book, ignores the occurrence of the bird in North-eastern Africa, and states that it represents *N. metallica* in Senegambia, though Von Heuglin notes that he found it between the Kosanga and Djur rivers, and Antinori also met with it in the latter locality. Emin Bey has also sent a specimen from Lado.

32. Cinnyris superbus (*Shaw*); *Shelley, Monogr. Nect.* pl. 60.

A male from Semmio, February. Iris blackish brown.

A splendid male bird, undistinguishable from Fantee examples. It has the under tail-coverts tipped with the same velvety maroon colour as the rest of the under surface, whereas many of the West-African specimens have these coverts entirely black. I found, however, on examination that others from the West Coast have the under tail-coverts tipped with maroon, and it is therefore probably only a sign of fuller plumage.

33. Cinnyris splendidus (*Shaw*); *Shelley, Monogr. Nect.* pl. 62.

Several specimens from Semmio, February. Iris blackish brown.

Identical with an adult male collected by the late Mr. W. A. Forbes at Lokoja on the Niger.

34. Cinnyris cupreus (*Shaw*); *Shelley, t. c.* pl. 58.—Nectarinia cuprea, *Heugl. t. c.* p. 231; *Hartl. op. cit.* vii. p. 108.

Adult males from Semmio, February. Iris blackish brown.

This specimen is somewhat peculiar in wanting the coppery glossy plumage of the mantle and back; in this respect it resembles examples from Gaboon, which have the back of a metallic lilac colour.

35. Cinnyris angolensis (*Less.*); *Shelley, Monogr. Nect.* pl. 87.

Adult males from Semmio, February. Iris blackish brown.

Identical with Gaboon specimens of this Sun-bird, hitherto supposed to be confined to the West Coast of Africa, where it ranges from Cameroons to Angola.

36. Cinnyris acik (*Antin.*); *Shelley, Monogr. Nect.* pl. 82.—

Nectarinia acik, *Antin.*; *Heugl. t. c.* p. 230; *Hartl. op. cit.* vii. p. 108.

Dem Suleiman and Dembachir.

The authority for Dr. Gadow's statement that *C. acik* "only appears to be different if compared with *C. cruentata* from the neighbouring countries, and that if compared with the western form it proves to be the same as *C. senegalensis*," appears to be his own *ipse dixit*; unless, indeed, he has united the two species from a desire to be different from Captain Shelley, as would appear to be frequently the case throughout his volume. Without seeing specimens it was somewhat rash to do this; and the series collected by Mr. Bohndorff amply proves that Captain Shelley was perfectly right in considering it a valid species.

37. Anthothreptes orientalis, *Hartl. Abhandl. Nat. Ver. Bremen*, vii. p. 109.

A pair of birds from Sassa, November. Iris dark brown.

The metallic green spot near the bend of the wing is much more pronounced than in the western specimens of *A. Longuemarii*, although a trace of it is evident in the last-named bird. The female, however, appears to differ from the same sex of *A. Longuemarii* in having the yellow of the abdomen extended to the lower breast.

Order II. *VOLUCRES.*

Cohors I. Psittaci.

38. Palæornis torquata (*Bodd.*); *Heugl. t. c.* p. 738; *Hartl. op. cit.* viii. p. 212.

Several beautiful specimens from Jur Gattas.

39. Pionias crassus, sp. n.

A single adult specimen from Ndoruma, November. Iris red.

The nearest ally of the present species appears to be *P. fuscicapillus*; but from this it is at once distinguished by the larger size and by the absence of yellow under the wing, the lower wing-coverts being grass-green, with emerald-green axillaries.

The following is a detailed description of the type specimen:—

Adult. General colour above grass-green, the feathers being brown, broadly edged and tipped with emerald-green on the back and scapulars, the wing-coverts being coloured like the back; bastard-wing and primary-coverts blackish, with dark bluish-green margins; quills dusky brown, with bluish-green edges to the primaries; the secondaries grass-green externally, with emerald-green tips and margins; lower back, rump, and upper tail-coverts bright emerald-green; tail-feathers olive-brown, margined and tipped with emerald-green; crown of head and nape brown, washed with yellowish olive, with here and there a concealed spot of bright yellow; forehead dusky brown, blackish on the lores; ear-coverts and cheeks light ashy brown, washed with yellowish olive; throat dull yellowish olive with blackish shaft-lines, the fore neck and chest gradually dusky brown, with ashy edges to some of the feathers; remainder of under surface of body bright emerald-green, with yellow bases to the feathers; thighs emerald-green externally, dull ashy internally; axillaries emerald-green like the breast; under wing-coverts darker grass-green, the median series washed with emerald-green; greater series dull ashy, slightly washed with green; quills ashy below, lighter towards the inner web. Total length 9·5 inches, culmen (without cere) 1·05, wing 6·55, tail 3·3, tarsus 0·55.

40. Pionias Meyeri (*Rüpp.*); *Heugl. t. c.* p. 743; *Hartl. op. cit.* vii. p. 114.

A number of specimens from Kutschugali.

Cohors II. Pici.

41. Mesopicus schoensis (*Rüpp.*).—Picus schoanus, *Heugl. op. cit.* ii. p. 809.—Picus schoensis, *Hartl. op. cit.* viii. p. 207.

A fine adult pair from Dem Suleiman, November.

It turns out that the bird supposed by Mr. Hargitt to be *M. schoensis* from Zanzibar, in Capt. Shelley's collection, is not really that species, but an intermediate form, for which I propose the name of *Mesopicus decipiens*. Like *M. schoensis* it has the black ear-stripe joined to the black cheeks; but the chest is barred as in *M. namaquus*. The true *M. schoensis*, as shown by Mr. Bohndorff's specimens, which agree with Rüppell's plate and Von Heuglin's descriptions, has the chest black, with small white spots. The female appears never to have been figured.

42. Mesopicus xantholophus, *Hargitt, Ibis*, 1883, p. 421.

Two females and a male from Semmio, August. Iris dark red.

This species has hitherto been supposed to exist only on the Congo river and in Gaboon. Its range is thus widely extended to the eastward. I have submitted the specimens to Mr. Hargitt, who confirms the identification.

43. Mesopicus goertan (*Gm.*); *Hargitt, Ibis*, 1883, p. 412. —Picus goertan, *Heugl. op. cit.* ii. p. 814; *Hartl. op. cit.* vii. p. 109.

A large series from Semmio.

In some individuals the pale bars on the tail are very distinct and reach nearly across the feather. Some specimens, however, from the West Coast of Africa also show this character.

44. Campothera caroli (*Malh.*); *Hargitt, Ibis*, 1883, p. 480.

A female bird from Sassa, identical with others from the Gold Coast in the British Museum. Mr. Hargitt also confirms this identification.

45. Campothera permista (*Reich.*); *Hargitt, Ibis*, 1883, p. 478.

Ndoruma, November. Iris blackish brown.

It is interesting to find that the species from the Nyam-nyam country is the same as that of the Gaboon and Congo instead of being the Gold-Coast species *C. maculosa*.

46. Campothera balia (*Heugl.*).—Picus balius, *Heugl. t. c.* p. 810.

A female from Semmio, January. Iris violet.

Mr. Hargitt, in his paper on the Woodpeckers of the Ethiopian Region, has united this species to *C. Cailliaudi* of Malherbe; and to judge from the description alone, which was all that Mr. Hargitt had to found his opinion upon, the two species would appear to be very similar. Heuglin's example was a male, and the specimen now sent by Mr. Bohndorff is a female; but I think there can be no doubt that it is identical with the species described by Heuglin. It seems to me that *C. balia* is a northern form of *C. Cailliaudi*, distinguished by its spotted mantle and upper back, and by the distinct black line along the upper edge of the ear-coverts, as well as by the moustache.

Cohors III. Coccyges.

Fam. Megalæminæ.

47. Pogonorhynchus Rolleti, *De Fil.*; *Heugl. t. c.* p. 750; *Hartl. op. cit.* vii. p. 112.

Adult male from Kutschugali, September. Iris blackish brown.

48. Pogonorhynchus bidentatus (*Shaw*); *Heugl. t. c.* p. 753; *Hartl. op. cit.* vii. p. 112.

Several specimens from Semmio.

49. Pogonorhynchus leucocephalus, *De Fil.*; *Heugl. t. c.* p. 754; *Hartl. op. cit.* vii. p. 112.

Males from Jur Gattas and Kutschugali.

Identical with a specimen from the Sudan (*Knoblecker*) in the British Museum.

50. Gymnobucco Bonapartii, *Verr.*; *Marshall, Monogr. Capit.* pl. 55.

An adult bird from Sassa, October. Cannot be separated from Gaboon examples, with two of which I have compared it.

Fam. Zanclostominæ.

51. Ceuthmochares intermedius, sp. n.

Several specimens from Semmio belong to the intermediate race of Gaboon and Cameroons, which does not yet seem to have received a name. The throat is lighter and more pearly grey than in *C. flavirostris* of Fantee, without the ochraceous tinge of *C. australis*. It has a steel-blue rump and tail with greenish lustre, not violet as in *C. flavirostris* or oily green as in *C. australis*.

Fam. Cuculinæ.

52. Cuculus solitarius, *Steph.*; *Sharpe, P. Z. S.* 1873, p. 582.

An adult bird from Semmio, not to be distinguished from West-African specimens in the British Museum.

53. Cuculus gularis, *Steph.*; *Sharpe, P. Z. S.* 1873, p. 585; *Hartl. op. cit.* vii. p. 113.

An adult bird from Sassa, September, exactly resembling others from South Africa.

54. Cuculus clamosus, *Lath.*; *Sharpe, P. Z. S.* 1873, p. 587; *Hartl. op. cit.* viii. p. 210.

Two immature birds from Semmio, March. Iris dark brown.

Sent by Emin Bey from Loronio; also procured by Piaggia in M' tesa's country.

55. Coccystes glandarius (*L.*); *Heugl. t. c.* p. 786; *Sharpe, P. Z. S.* 1873, p. 595.—Oxylophus glandarius, *Hartl. op. cit.* viii. p. 210.

An adult bird from Jur Gattas and a young one from Semmio.

56. Coccystes cafer (*Licht.*); *Sharpe, P. Z. S.* 1873, p. 596. —Oxylophus afer, *Heugl. t. c.* p. 790; *Hartl. op. cit.* viii. p. 210.

Old and young birds from Kutschugali and Semmio.

57. Cuculus Klaasi, *Steph.*; *Sharpe, P. Z. S.* 1873, p. 592.—Chalcites Clasii, *Hartl. op. cit.* viii. p. 209.—Chrysococcyx Claasii, *Heugl. t. c.* p. 778.

Specimens of both sexes from Semmio.

Cohors IV. Cœnomorphæ.

Fam. Musophaginæ.

58. Turacus giganteus (*Vieill.*); *Hartl. Orn. Westafr.* p. 159.

Mr. Bohndorff brought back an immense series of this bird from Semmio, where he says it is very abundant.

59. Musophaga Rossæ, *Gould*; *Hartl. Orn. Westafr.* p. 160.

Several fine specimens from Semmio, February. Iris dark brown.

The occurrence of this splendid bird in the interior of Africa is surprising, as it has hitherto been supposed to be confined to Angola. I have compared Mr. Bohndorff's specimens with the type in the British Museum.

60. Corythaix Schuetti, *Cab. Orn. Centralbl.* 1879, p. 180.

♀. Semmio, March. Iris dark brown.

From the description published by Professor Cabanis, I have no doubt that the birds procured by Mr. Bohndorff belong to *C. Schuetti* of Angola. After the occurrence of *Musophaga Rossæ* in the Nyam-nyam country, it is only natural to expect to find the present species, which occurred alongside of it in the interior of Angola explored by Dr. Schütt.

61. Corythaix leucolopha, *Heugl. t. c.* p. 703, Taf. 24. *Hartl. op. cit.* viii. p. 210.

This species appears to be common in the Nyam-nyam country, as Mr. Bohndorff obtained a large series in Semmio and Nduruma.

62. Schizorhis zonura, *Rüpp.*; *Heugl. t. c.* p. 705; *Hartl. op. cit.* vii. p. 114.

Adult specimens from Kutschugali, September.

Fam. Coliinæ.

63. Colius nigricollis, *V.*; *Hartl. Orn. Westafr.* p. 155.

A specimen from Ndoruma, October. "Iris white."

This bird agrees best with Congo specimens in the British Museum, but the crest is very much paler and of a whity brown colour.

Fam. Coraciinæ.

64. Eurystomus afer (*Lath.*); *Heugl. t. c.* p. 169; *Hartl. op. cit.* vii. p. 110.

A female from Kutschugali, shot in September.

Cohors V. Ampligulares.

Fam. Trogoninæ.

65. Hapaloderma narina (*Vieill.*); *Heugl. t. c.* p. 176.

Several specimens from Semmio, of both sexes.

Fam. Caprimulginæ.

66. Caprimulgus europæus, *L.*; *Heugl. Orn. N.O.-Afr.* i. p. 125; *Hartl. op. cit.* vii. p. 109.

Several specimens from Dongola.

67. Cosmetornis vexillarius (*Gould*).—Macrodipteryx vexillarius, *Heugl. Orn. N.O.-Afr.* i. p. 134.

An adult female from Semmio, March.

68. Scotornis longicauda (*Drap.*); *Heugl. Orn. N.O.-Afr.* i. p. 133; *Hartl. op. cit.* viii. p. 207.

A specimen from Ndoruma, November.

This bird is very rufous in colour, but the markings appear characteristic.

Cohors VI. Volucres Syndactylæ.

69. Merops ægyptius, *L.*—M. superciliosus (*L.*); *Heugl. t. c.* p. 197.

A specimen from Semmio in changing plumage, killed in December.

70. Merops nubicus, *Gm.*; *Heugl. t. c.* p. 199; *Hartl. op. cit.* vii. p. 111.

Kaueh, February (three days beyond Khartoum).

71. Merops angolensis, *Gm.*; *Sharpe, Cat. Afr. B.* p. 3.

An adult bird from Muschra Rec, which agrees with others from Gaboon. It is interesting to find this species and not *M. Lafresnayii.*

Fam. Alcedininæ.

72. Alcedo quadribrachys, *Bp.*; *Hartl. Orn. Westafr.* p. 34.

Several adult examples from Ndoruma and Semmio, March. Iris blackish brown.

Identical with Gaboon specimens in the Museum.

73. Halcyon chelicutensis (*Stanl.*); *Hartl. op. cit.* viii. p. 207.—Dacelo tschelicutensis, *Heugl. t. c.* p. 192.

A few specimens from Dem Bakir.

74. Halcyon malimbica (*Shaw*); *Sharpe, Monogr. Alced.* pl. 72.

Adult birds from Semmio. The specimens agree with Mr. Forbes's Niger example and the Fantee skins in the British Museum, and not with the Gaboon birds.

75. Halcyon cyanoleuca (*Vieill.*); *Sharpe, Monogr. Alced.* pl. 69.

Adults and immature birds from Juku and Semmio.

76. Halcyon semicærulea (*Forsk.*); *Hartl. op. cit.* vii. p. 110. —Dacelo semicærulea, *Heugl. t. c.* p. 190.

Adults and immature birds from Semmio.

77. Ispidina picta (*Bodd.*); *Hartl. op. cit.* viii. p. 207.—Alcedo picta, *Heugl. Orn. N.O.-Afr.* i. p. 183.

Adult and young birds from Semmio.

Fam. Bucerotinæ.

78. Tockus erythrorhynchus (*Temm.*); *Elliot, t. c.* pl. lvi.—Buceros erythrorhynchus, *Heugl. t. c.* p. 727; *Hartl. op. cit.* vii. p. 112.

A female from Dembo, June.

79. Tockus fasciatus (*Shaw*); *Elliot, t. c.* pl. l. fig. 2.

From Semmio, February, and Ndoruma in September. The latter specimen is young, and is brown instead of black, while the penultimate tail-feather is black tipped with white as in *T. semifasciatus.* The third feather is white for its entire length. The white tip to the penultimate feather being one of the specific characters by which *T. semifasciatus* is distinguished from *T. fasciatus*, it is an interesting piece of evidence of the close alliance of the two species, that *T. fasciatus* goes through a stage of plumage resembling the features of the adult *T. semifasciatus*.

80. Tockus camurus, *Cass.*; *Elliot, t. c.* pl. lix.

A specimen from Sassa, October, agrees with others from Gaboon in the British Museum.

81. Pholidophalus Sharpii (*Elliot*); *Elliot, t. c.* pl. xxxiii.

A specimen from Ndoruma. Identical with the type in the British Museum from Angola.

82. Sphagolobus atratus (*Temm.*); *Elliot, t. c.* pl. xxiv.—Buceros atratus, *Hartl. op. cit.* viii. p. 208.

A large series from Semmio, illustrating the changes of the species from youth to age. The young male evidently commences life with a rufous plumage like the female, as traces of it are to be seen in one of the male birds; but apparently the bill is like that of the old male in form, without such a large development of casque.

Cohors VII. Peristeroideæ.

83. Treron calva (*Temm.*); *Shelley, Ibis*, 1883, p. 267.—T. nudirostris, *Heugl. t. c.* p. 821; *Hartl. op. cit.* vii. p. 117.

A series from Sassa and Semmio.

84. Treron waalia (*Gm.*); *Heugl. t. c.* p. 817; *Shelley, Ibis*, 1883, p. 265; *Hartl. op. cit.* vii. p. 117.

Several specimens from Jur Gattas and Dem Suleiman.

85. Columba guinæensis, *Bonn.*; *Heugl. t. c.* p. 822; *Hartl. op. cit.* viii. p. 216; *Shelley, t. c.* p. 278.

A female from Jur Gattas, November. Iris ochre-yellow.

Order III. *ACCIPITRES.*

86. Gypohierax angolensis (*Gm.*); *Heugl. t. c.* p. 106, note; *Sharpe, Cat. B.* i. p. 312.

A considerable series of old and young birds was brought by Mr. Bohndorff, who says that it was plentiful in the Nyam-nyam country wherever the Elæis palm is found. It is very fond of the fruit of this palm and devours it, as well as feeding on small antelopes &c. The late Baron von Heuglin believed he saw this species on the Kosanga river; and there can be little doubt of the correctness of his surmise.

87. Polyboroides typicus, *Smith*; *Sharpe, Cat. B.* i. p. 48.—P. radiatus, *Heugl. t. c.* p. 76.

A fine adult male from Semmio, March.

88. Butastur rufipennis (*Sund.*); *Sharpe, Cat. B.* i. p. 299. —Poliornis rufipennis, *Heugl. t. c.* p. 95; *Hartl. op. cit.* viii. p. 213.

An adult female from Kutschugali, procured in October.

89. Asturinula monogrammica (*Temm.*); *Sharpe, Cut. B.* i. p. 275; *Hartl. op. cit.* vii. p. 115.—Astur monogrammicus, *Heugl. t. c.* p. 64.

Adult birds from Kutschugali and Semmio.

90. Melierax polyzonus (*Rüpp.*); *Sharpe, Cat. B.* i. p. 88. —Astur mechowi, *Cab.*; *Hartl. op. cit.* viii. p. 213.—Astur polyzonus, *Heugl. t. c.* p. 61.

Two adult birds from Kutschugali, August.

The differences on which Prof. Cabanis has founded his *Melierax mechowi* seem to me to be purely individual, as in the series of twelve birds, all adults, in the British Museum, every gradation between a uniform and a closely barred wing can be found, and I believe that the uniformly marked birds are simply the more adult.

91. Astur sphenurus (*Rüpp.*); *Sharpe, Cat. B.* i. p. 112.—Nisus sphenurus, *Hartl. op. cit.* viii. p. 214.—N. badius, *Heugl. t. c.* p. 70.

An adult male from Sassa, and one from Semmio with remains of immature plumage. The species was also in the collection from Juku.

92. Helotarsus ecaudatus (*Daud.*); *Heugl. t. c.* p. 80; *Sharpe, t. c.* p. 300.

A fine adult female from Mangiri, October. This was the only specimen obtained by Mr. Bohndorff, though he says they are common. They are, however, very shy; and the present specimen was only got by finding the nest, and shooting the old bird as she flew off.

93. Pernis apivorus (*L.*); *Heugl. t. c.* p. 97; *Sharpe, Cat. B.* i. p. 344.

An adult bird from Sassa, November; and a younger bird from Semmio.

94. Baza cuculoides (*Swains.*); *Sharpe, Cat. B.* i. p. 354, pl. xi. fig. 2.—Aviceda cuculoides, *Heugl. t. c.* p. 106, note.

A pair of birds from Semmio, February. They are identical with Gaboon specimens. Baron von Heuglin identified a bird seen, but not procured, by him in the country of the Dor Negros as being probably of the present species, and he was no doubt correct in the identification.

95. Cerchneis ardesiaca (*Bon. & Vieill.*); *Sharpe, Cat. B.* i. p. 446.—Falco ardesiacus, *Heugl. t. c.* p. 34; *Hartl. op. cit.* vii. p. 115.

Two adult birds from Ndoruma, September. Identical with Senegambian and Bogos specimens.

96. Cerchneis tinnunculus (*L.*); *Sharpe, Cat. B.* i. p. 425. —F. tinnunculus, *Heugl. t. c.* p. 40.

A young male from Jur Gattas, shot in November, of the ordinary European type, and not belonging to the dark resident race of the Abyssinian highlands.

97. Falco ruficollis, *Sw.*; *Sharpe, Cat. B.* i. p. 404; *Hartl. op. cit.* vii. p. 115.—F. chicquera, *Heugl. t. c.* p. 36.

Two immature birds from Semmio, April.

Mr. Gurney very aptly refers to my omission of the young plumages in my description of the species (*l. c.*). I had not at that time any immature birds in the Museum collection; but he has supplied some very good notes on the subject in the 'Ibis' for 1882 (p. 162).

A young bird of this species may be recognized at a glance by its much darker colour, dusky mantle, broader black bars, dusky rufous head, with broad black centres to the feathers, and by the rufous margins to the feathers of the upper parts. The change to the uniform rufous head and blue-grey upper surface is by a direct moult, the new feathers on the back being light blue-grey with narrow black cross bars. On the under surface of the body the rufous colouring of the breast is more of a sienna-colour and the throat is also rufescent, while the flanks are also nearly uniform; the cross bars on the flanks and sides of the breast are also broader and coarser.

98. Bubo cinerascens, *Guér.*; *Sharpe, Cat. B.* ii. p. 32; *Hartl. op. cit.* viii. p. 215.

An adult bird from Ndoruma, killed in July. It seems to be identical with specimens from Bogos Land in the Museum, and not with true *B. maculosus* of South Africa.

99. Scops giu (*Scop.*); *Sharpe, Cat. B.* ii. p. 47.—S. zorca, *Heugl. t. c.* p. 117.

An adult male from Dembo (a zereeba on the Bahr el Ghazal), July. This specimen is undoubtedly identical with European and Senegambian examples.

100. Glaucidium perlatum (*Vieill.*); *Sharpe, Cat. B.* ii. p. 209. —Athene perlata, *Hartl. op. cit.* vii. p. 215.—Noctua perlata, *Heugl. t. c.* p. 120.

Several individuals from Sassa and Semmio.

An Abyssinian specimen in the British Museum has seven bars on the tail, and the example retained by the latter institution from Semmio has six white bars.

101. Syrnium Bohndorffi, sp. n.

From Semmio and Ndoruma.

Closely allied to *S. nuchale*, Sharpe, but distinguished at once by its deep cinnamon colour above, with scarcely any white spots, and by the absence of the large white spots on the wing-coverts, which are thus almost entirely uniform. The breast, instead of being broadly barred across, has only some small white spots and bars. The specimens brought by Mr. Bohndorff have been compared with five adult specimens of *S. nuchale* from the Gold Coast and Gaboon.

I subjoin a description of the typical example:—

Adult. General colour above dark cinnamon-rufous, with scarcely an indication of any vermiculations, excepting a few on the lower back and upper tail-coverts, the latter having indications of fulvescent spots along the shafts; scapulars lighter rufous externally, inclining to tawny buff towards the base, and with a large quadrate spot of white near the end of the outer web; wing-coverts nearly uniform rufous brown, the outer webs of the greater series lighter rufous and with a slight indication of dusky vermiculations and a whitish spot towards the end of the outer web; bastard wing blackish, with rufous bars on the outer web; primary-coverts uniform black, excepting a rufous bar at the end; quills regularly barred with blackish and light rufous brown, the inner secondaries pale cinnamon, with light brown cross bars; tail-feathers barred with blackish and light rufous, the centre ones with five pale bars including the tip, the light bars being seven in number on the outer feathers; crown of head uniform cinnamon-brown, with black shaft-streaks and a few tiny spots of buffy white; the hind neck lighter cinnamon and with a few more distinct diamond-shaped spots of white; loral plumes white, extending above the eye, the latter having a black line round it; ear-coverts rufescent, with dusky blackish cross lines; cheeks dull white, with dusky cross bars; remainder of under surface of body light cinnamon-rufous, with a few white spots and bars on the breast, the abdomen and flanks being broadly barred with white, each white bar being bordered above and below with a line of blackish; thighs and vent yellowish buff; the under tail-coverts white, slightly barred with rufous near their ends; under wing-coverts and axillaries light cinnamon-buff, with a few dusky bars near the edge of the wing; the lower series yellowish buff, with broad black ends, resembling the under surface of the wing, which is blackish, barred and tipped with dull rufous. Total length 13 inches, wing 10·1, tail 5·5, tarsus 1·6.

102. STRIX FLAMMEA, *L.*; *Heugl. t. c.* p. 123; *Sharpe, Cat. B.* ii. p. 291.

A female from Semmio, February.

Of the usual dark African type, with numerous spots.

Order V. *GRALLATORES.*

Series I. GRALLATORES ALTINARES.

Cohors I. HERODII.

Fam. ARDEINÆ.

103. BOTAURUS STURMI (*Wagl.*); *Heugl. t. c.* p. 1078; *Hartl. op. cit.* viii. p. 215.—Ardea Sturmi, *Heugl. t. c.* p. 1078.

An adult bird from Semmio, killed in March.

104. BUTORIDES ATRICAPILLA (*Afzel.*).—Ardea atricapilla, *Heugl. t. c.* p. 1080.

An adult specimen in full plumage from Semmio, May.

Cohors II. PELARGI.

Fam. CICONIINÆ.

105. ANASTOMUS LAMELLIGERUS, *Temm.*; *Heugl. t. c.* p. 1119.

A single specimen from Dem Bakir, May; in very worn plumage.

Cohors IV. Cursores.

Fam. Charadriinæ.

106. Hoplopterus spinosus (*L.*); *Heugl. Orn. N.O.-Afr.* ii. p. 1004.

A fine specimen from the Gazelle River.

Identified by Mr. Harting.

107. Lobivanellus senegalus (*L.*).—L. senegalensis, *Heugl. Orn. N. O.-Afr.* ii. p. 1000.

A female from Kutschugali, September.

Fam. Rallinæ.

108. Parra africana, *Gm.*; *Heugl. t. c.* p. 1216; *Hartl. op. cit.* vii. p. 119.

Several specimens from Muschra Rec.

109. Porphyrio Alleni, *Thomps.*; *Heugl. t. c.* p. 1228; *Hartl. op. cit.* viii. p. 219.

An adult specimen from Muschra Rec.

110. Corethrura cinnamomea (*Less.*); *Hartl. Orn. West-afr.* p. 242.

Ndoruma, November. Iris clear brown.

Identical with West-African specimens in the British Museum.

111. Limnocorax niger (*Sw.*).—Ortygometra nigra, *Heugl. t. c.* p. 1237; *Hartl. op. cit.* vii. p. 119.

An adult specimen from Muschra Rec, March.

Order VII. *NATATORES.*

Cohors V. Totipalmatæ.

Fam. Anatinæ.

112. Dendrocygna viduata (*L.*); *Heugl. Orn. N.O.-Afr.* ii. p. 1298.

A female procured at Kutschugali in September.

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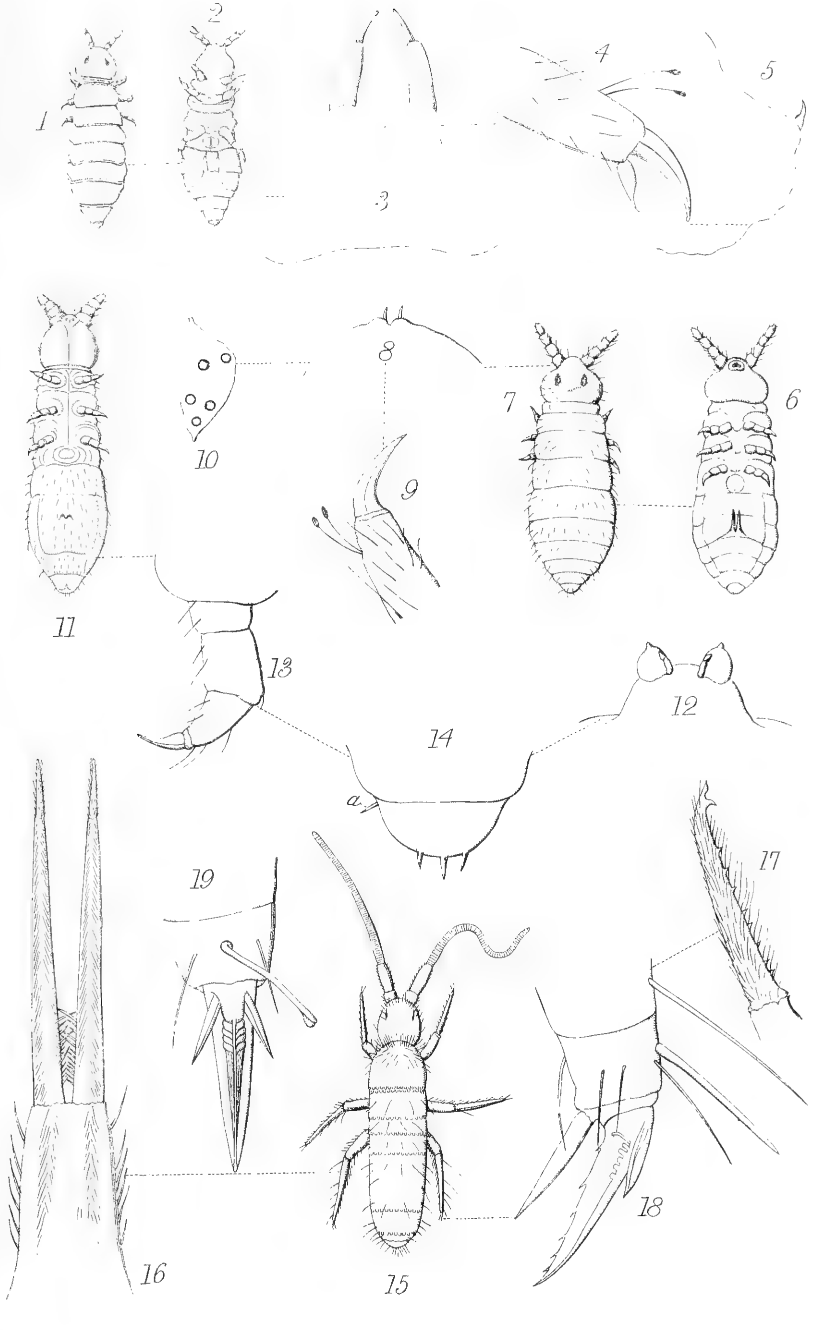
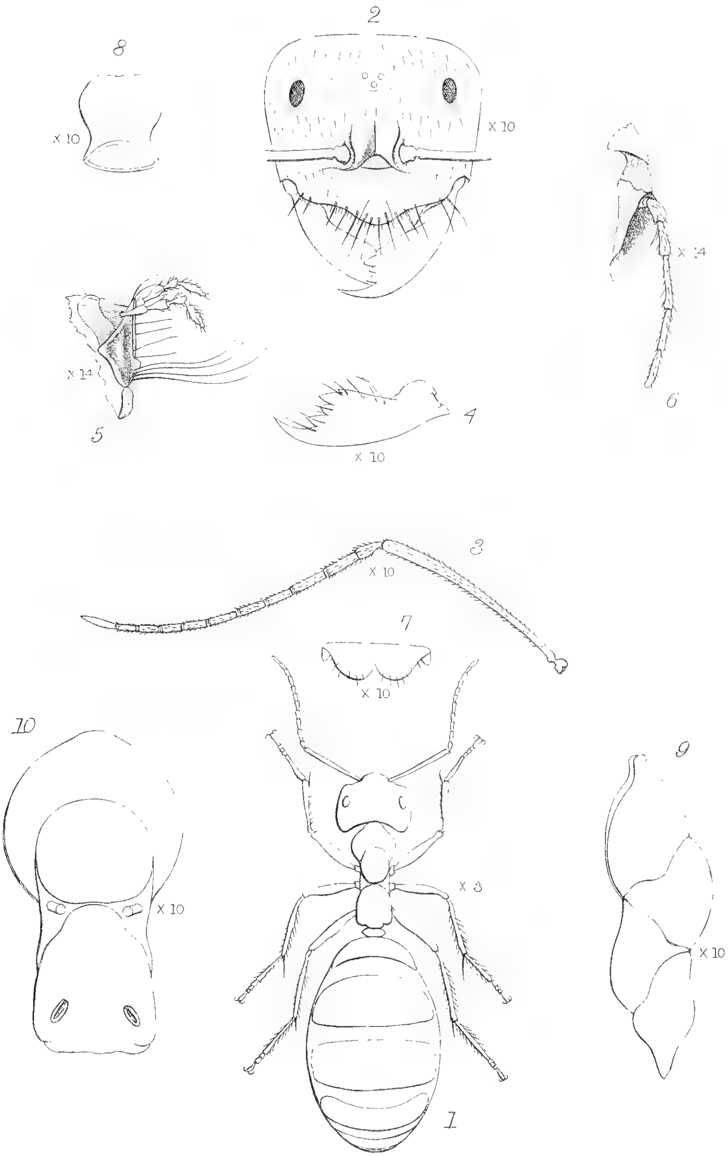
Printed by Taylor and Francis, Red Lion Court, Fleet Street.



Jarman sc. BRITISH COLLEMBOLA Hanhart imp.



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NEW GENUS OF HONEY-ANT.
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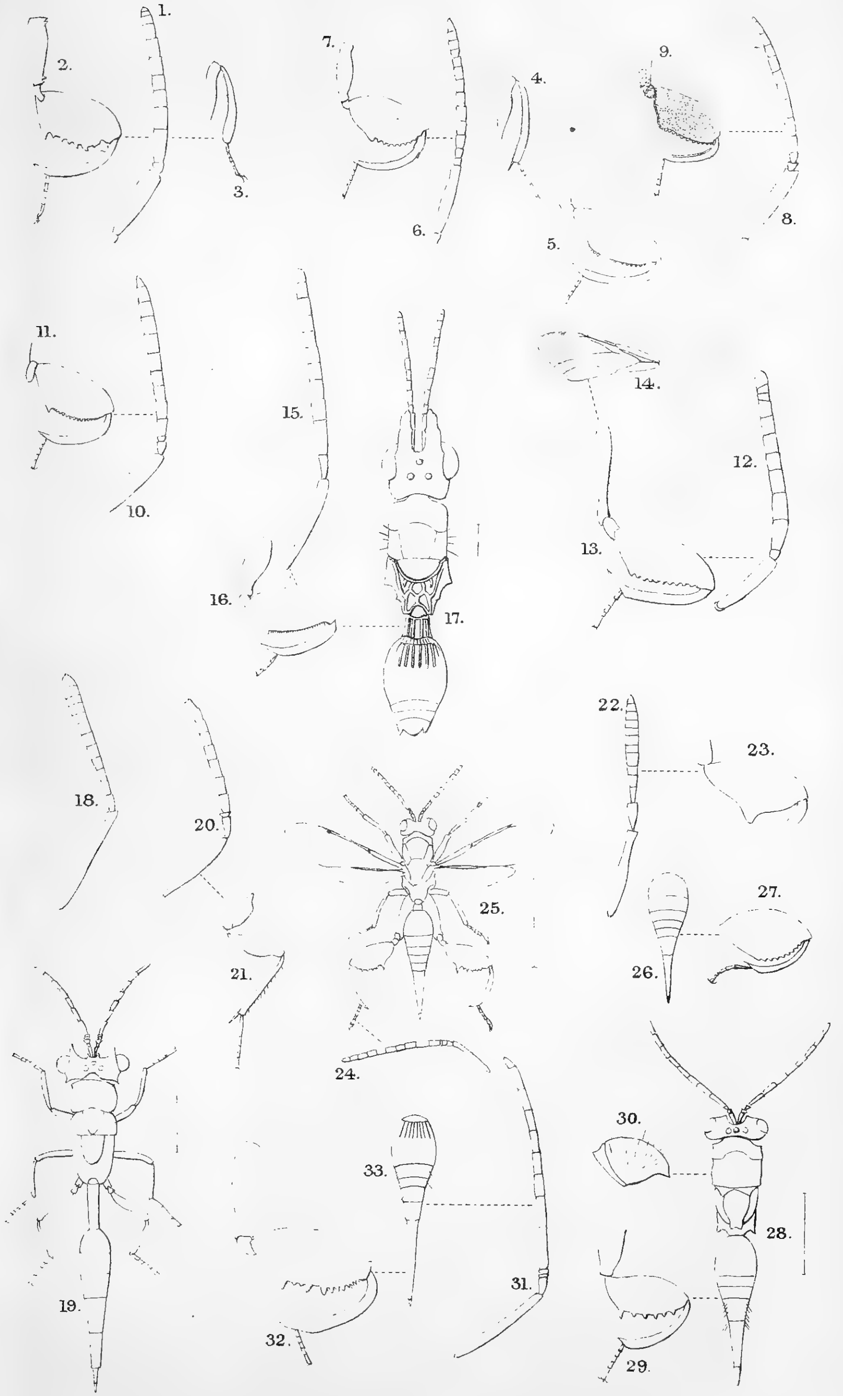
Hanhart imp.



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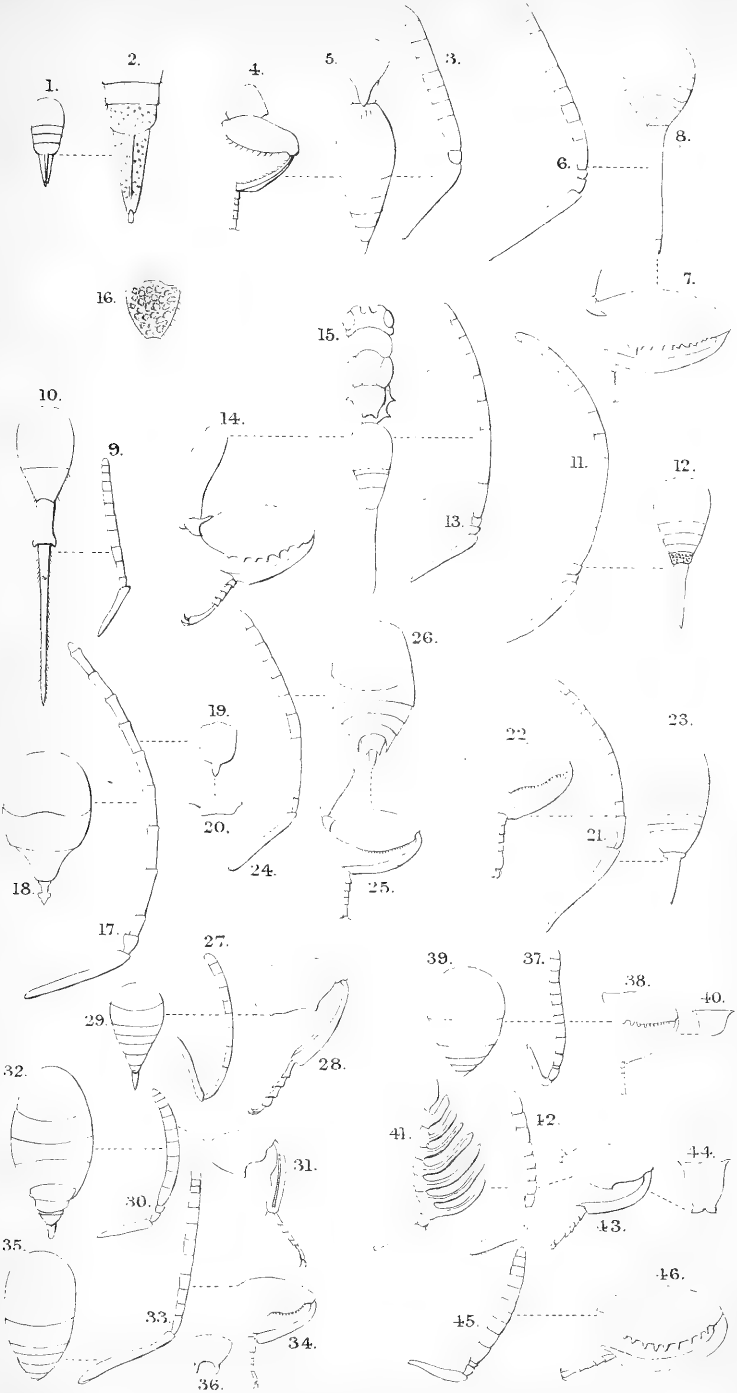

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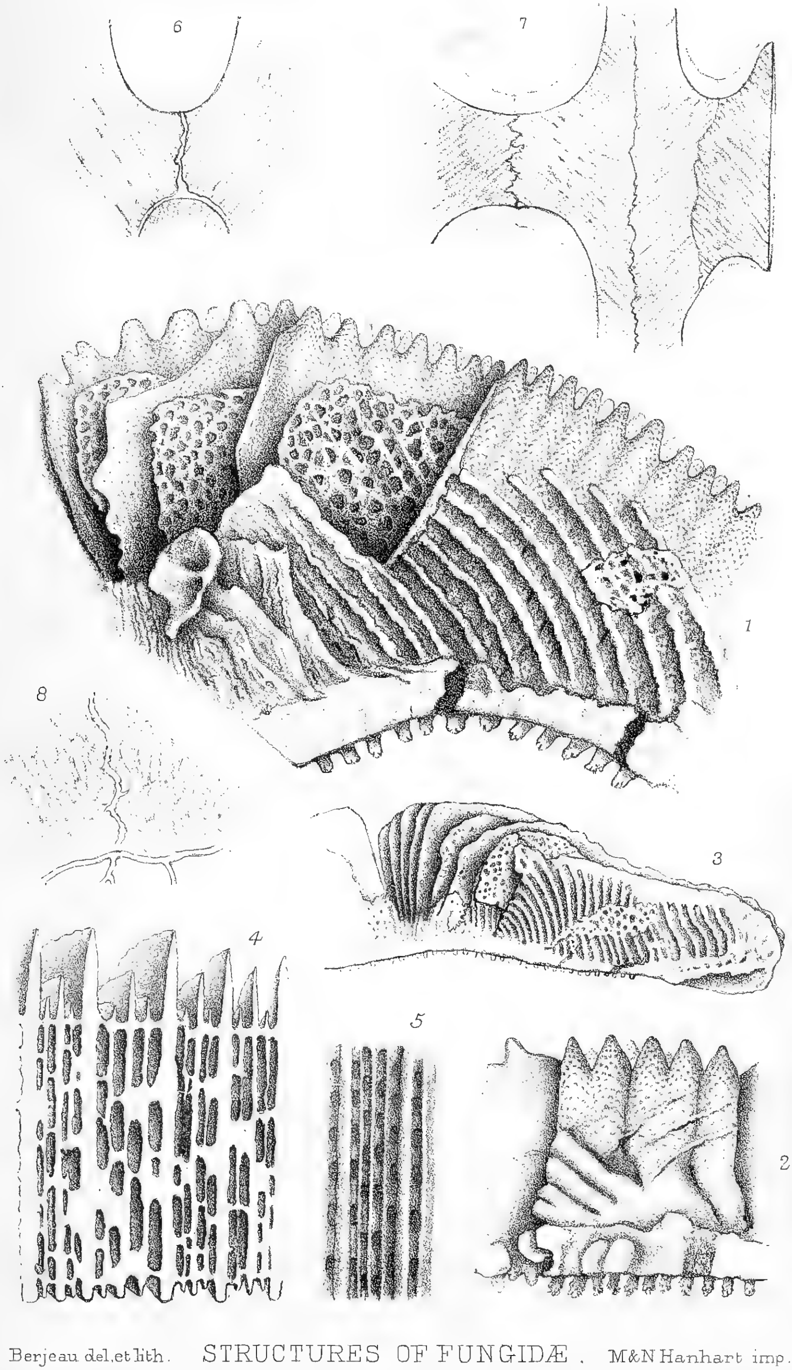

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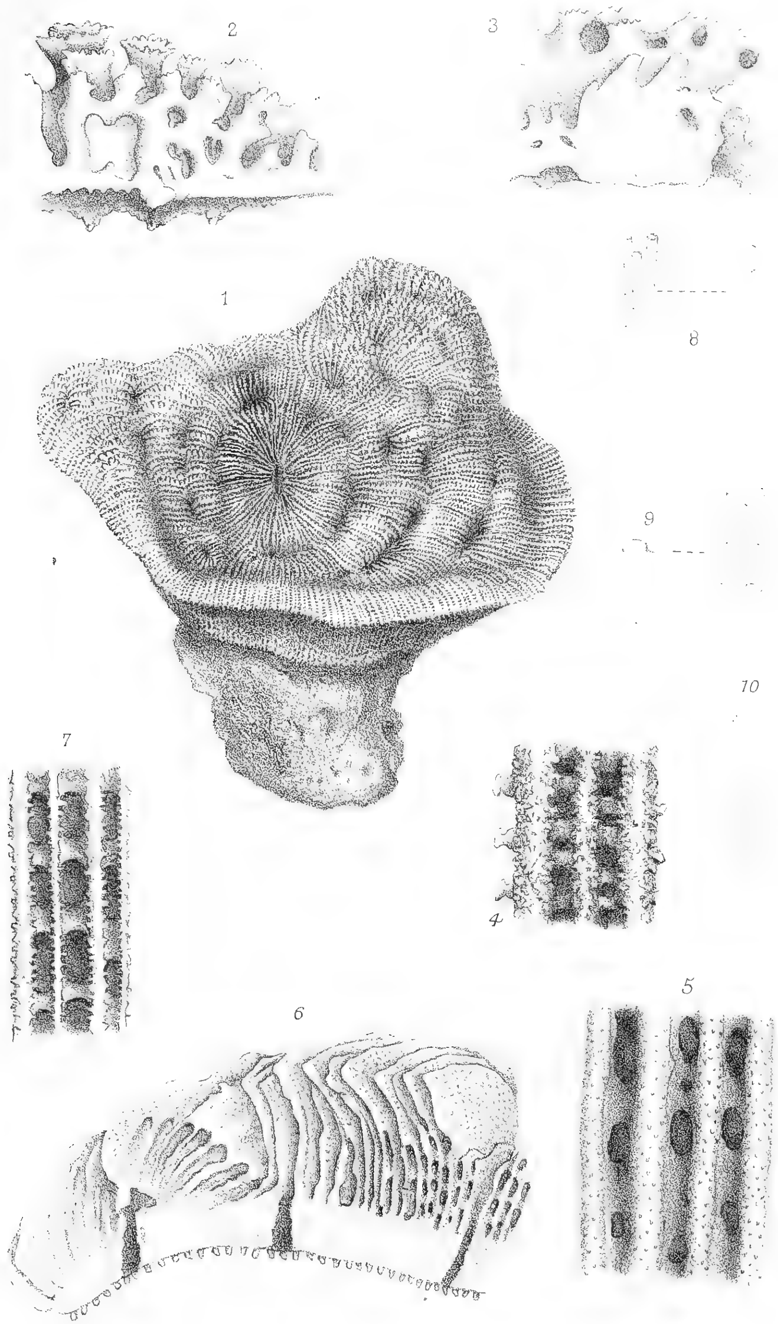

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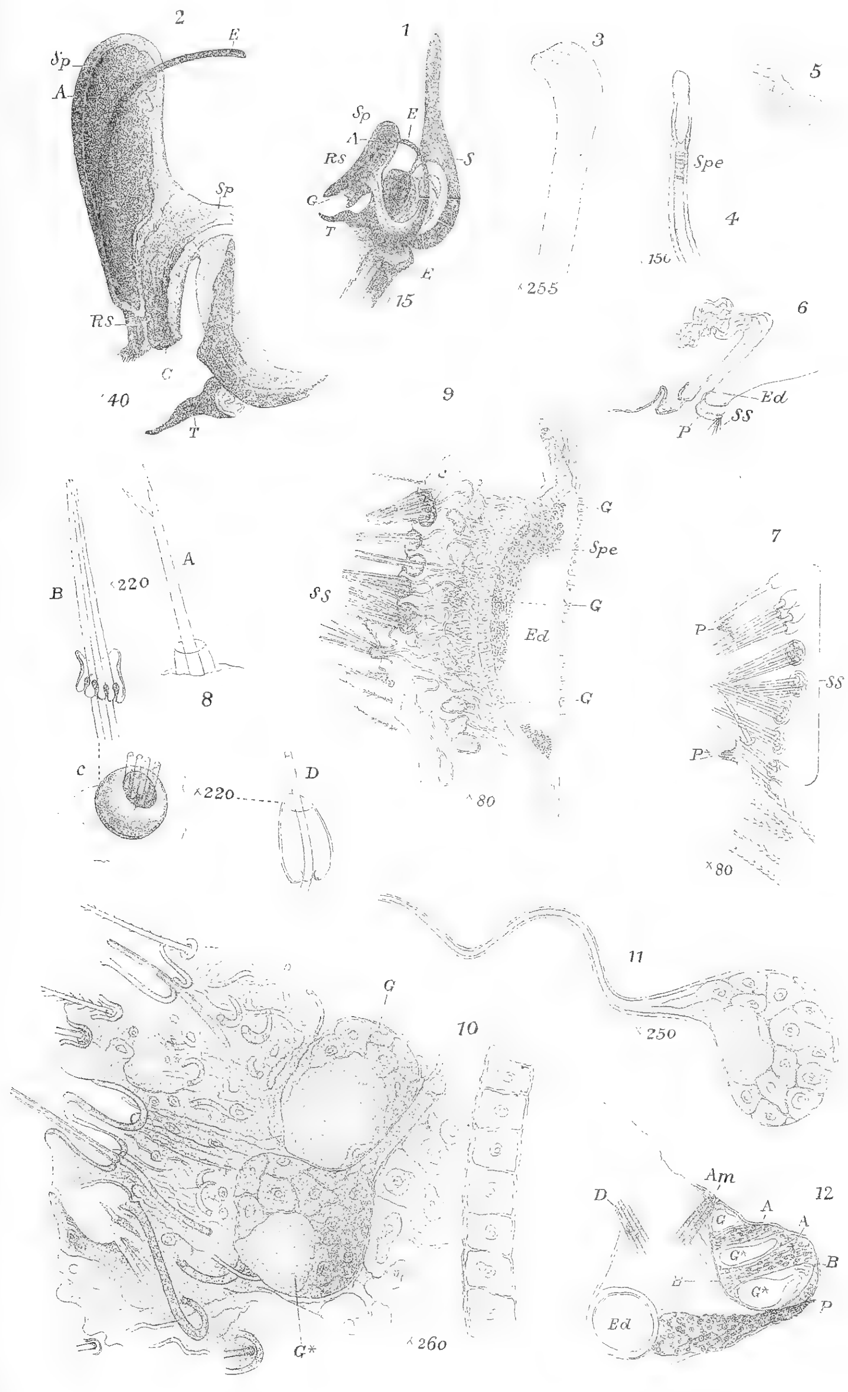
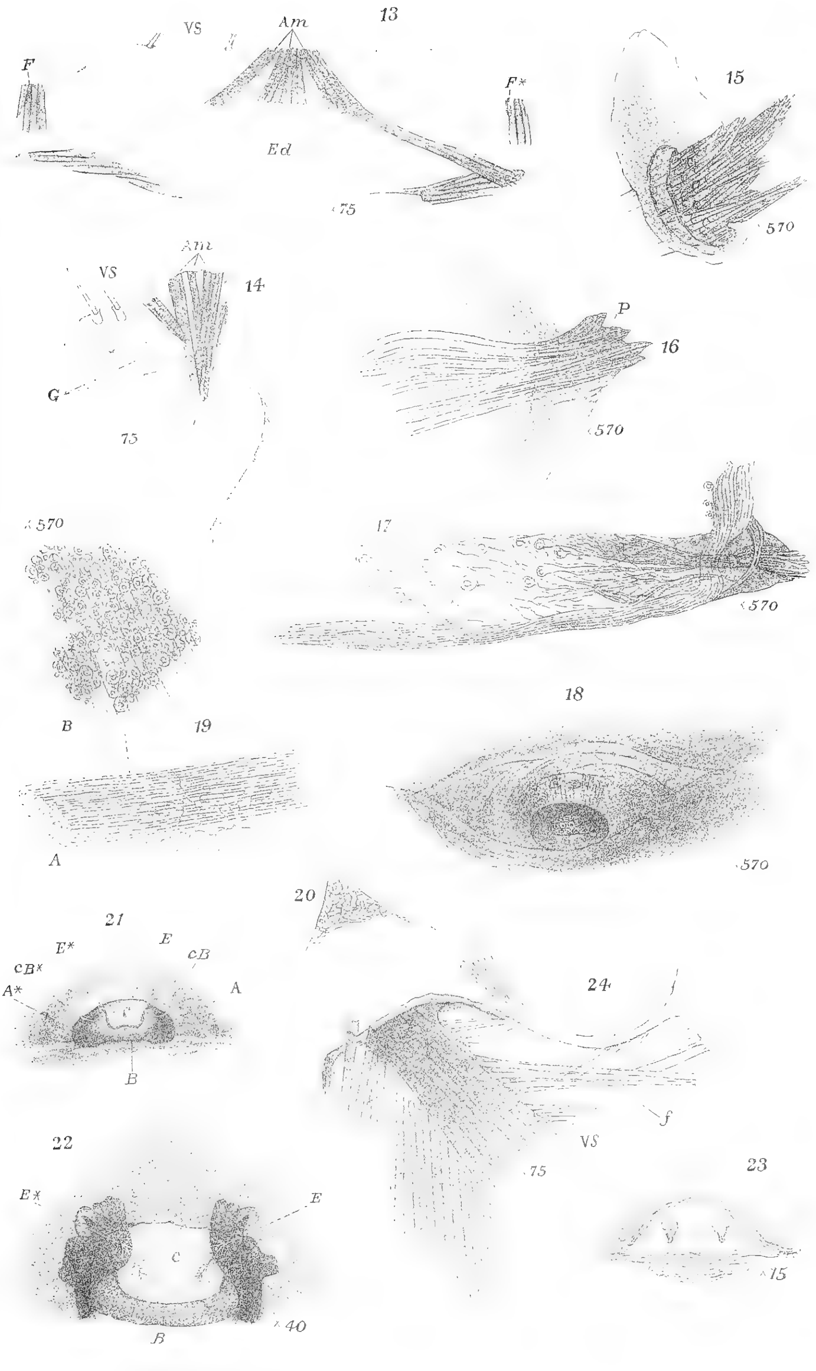


STRUCTURE MALE SEXUAL ORGANS OF TEGENARIA.



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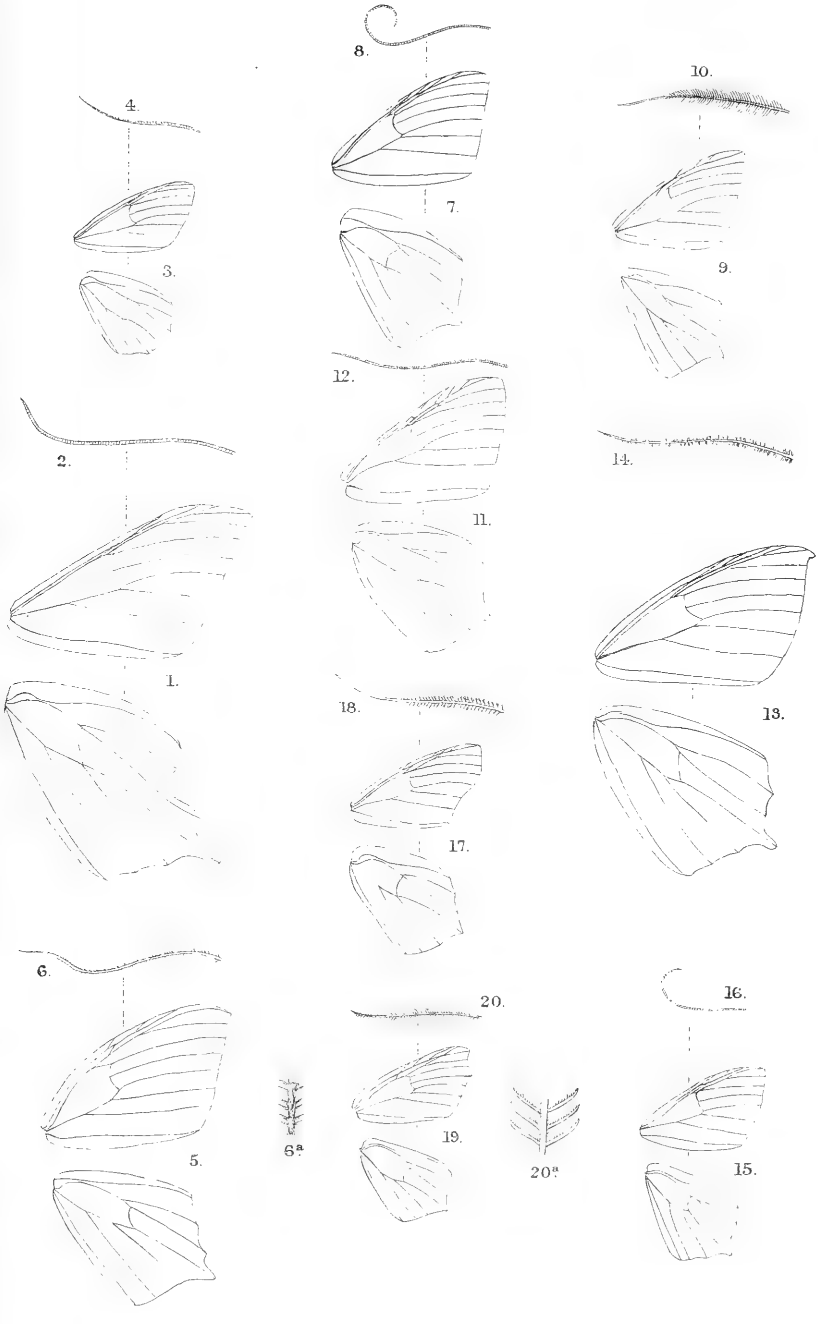

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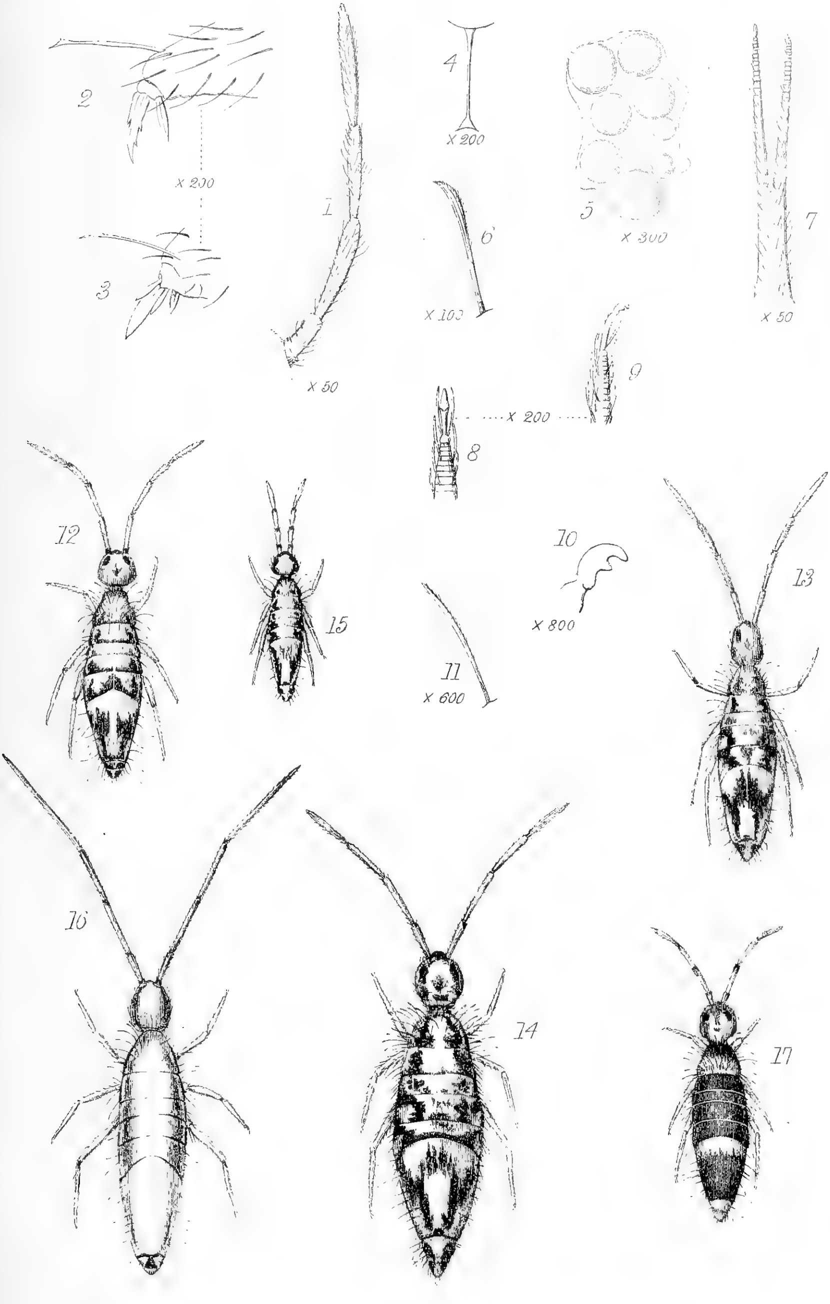

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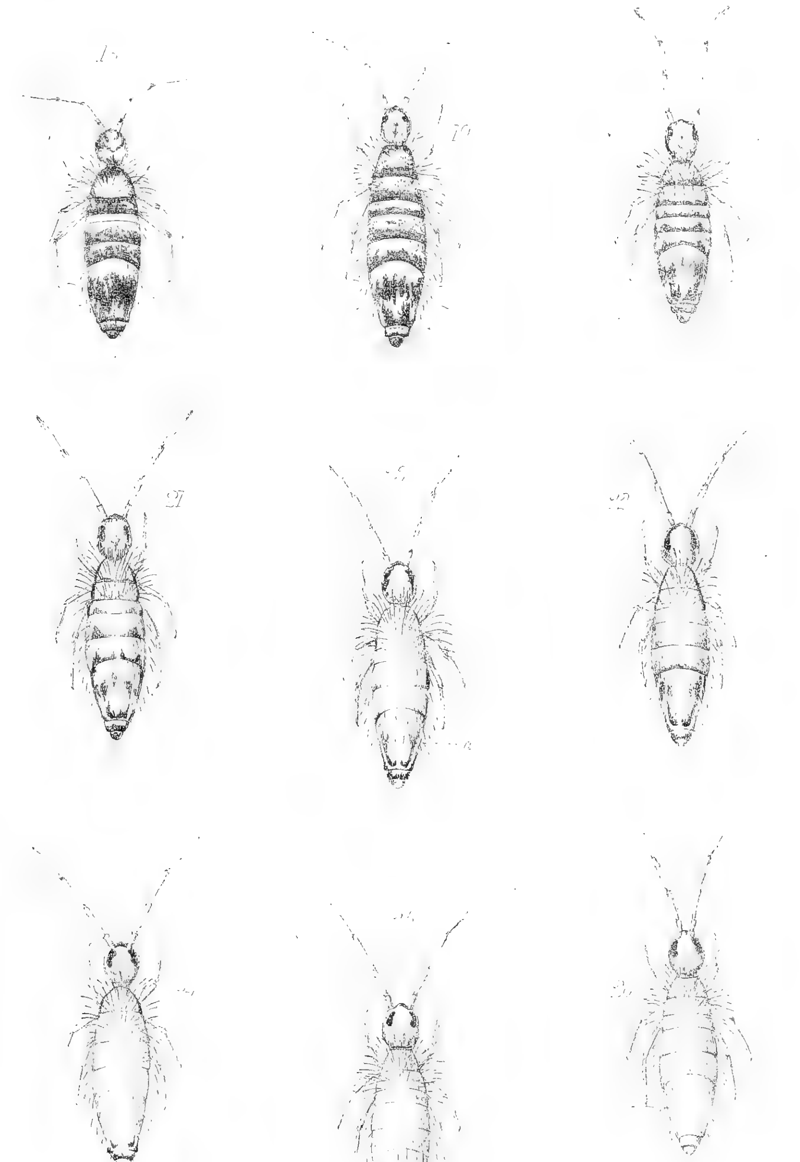

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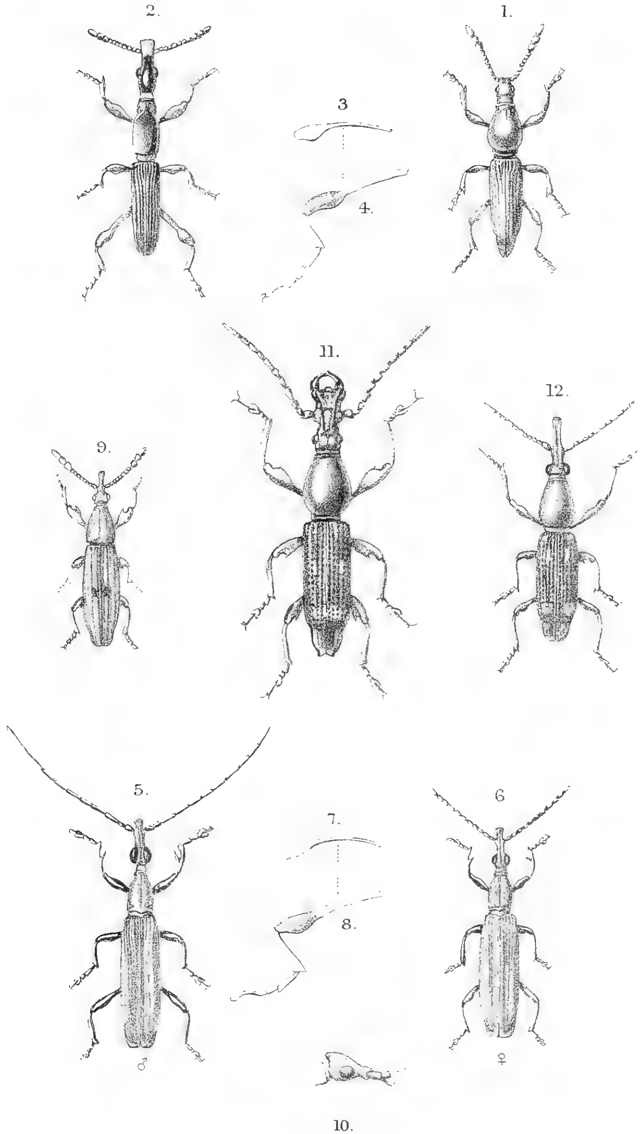

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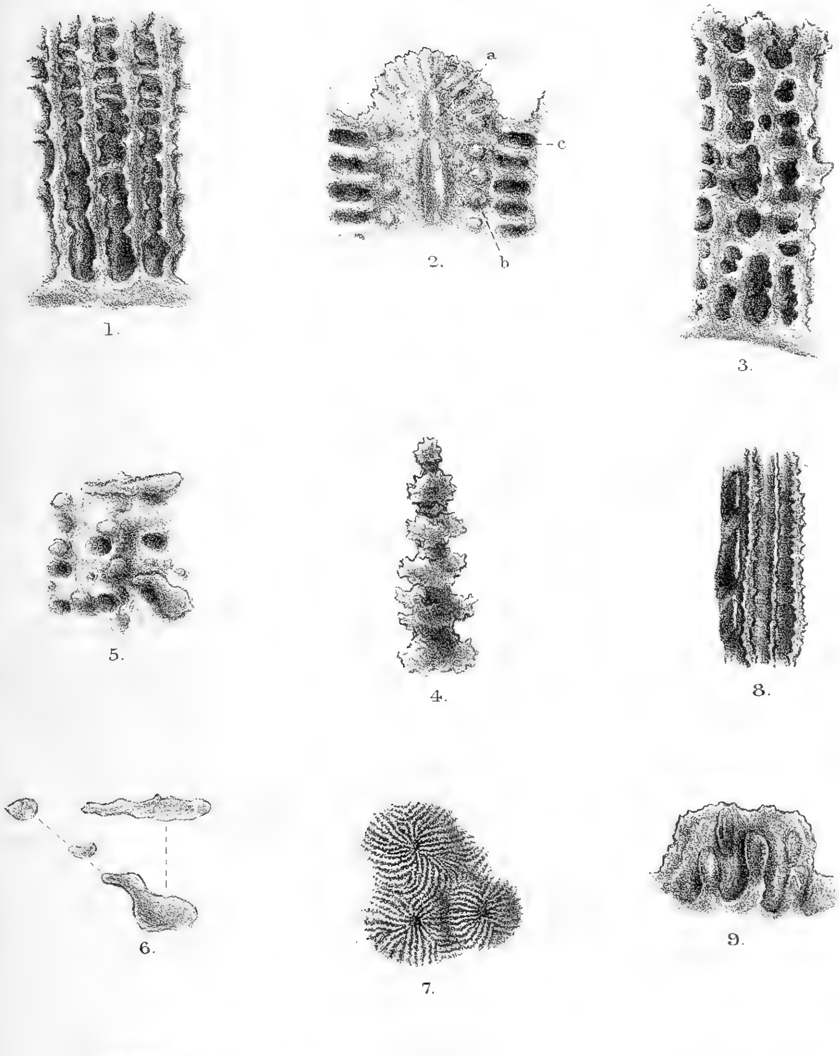

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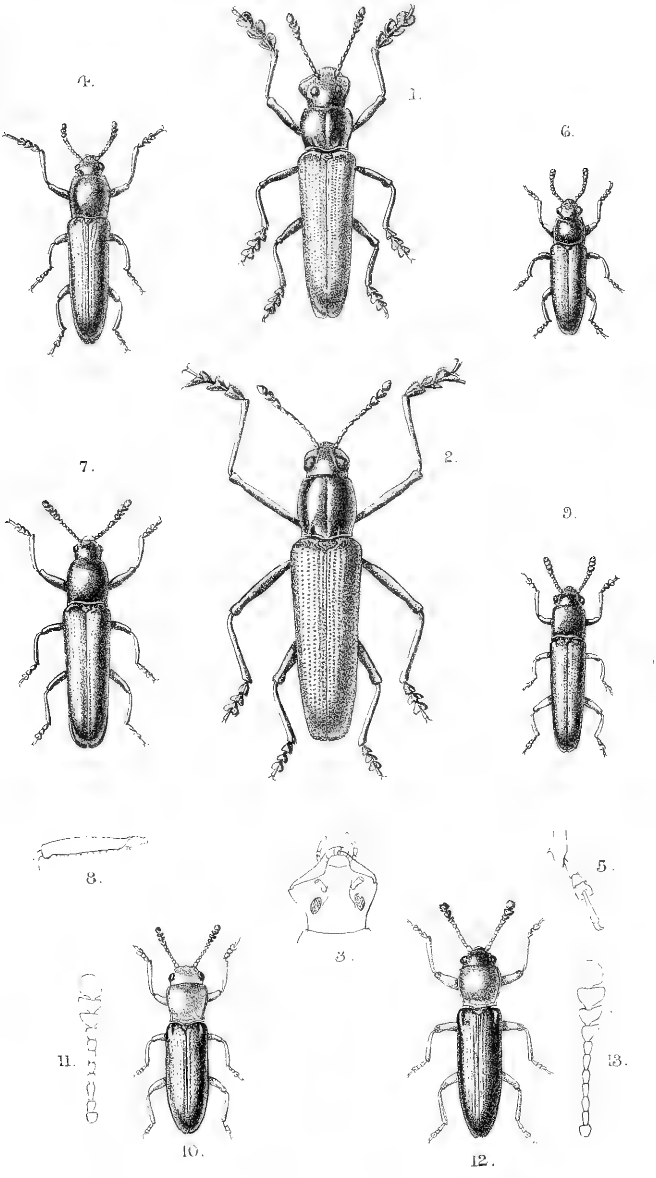

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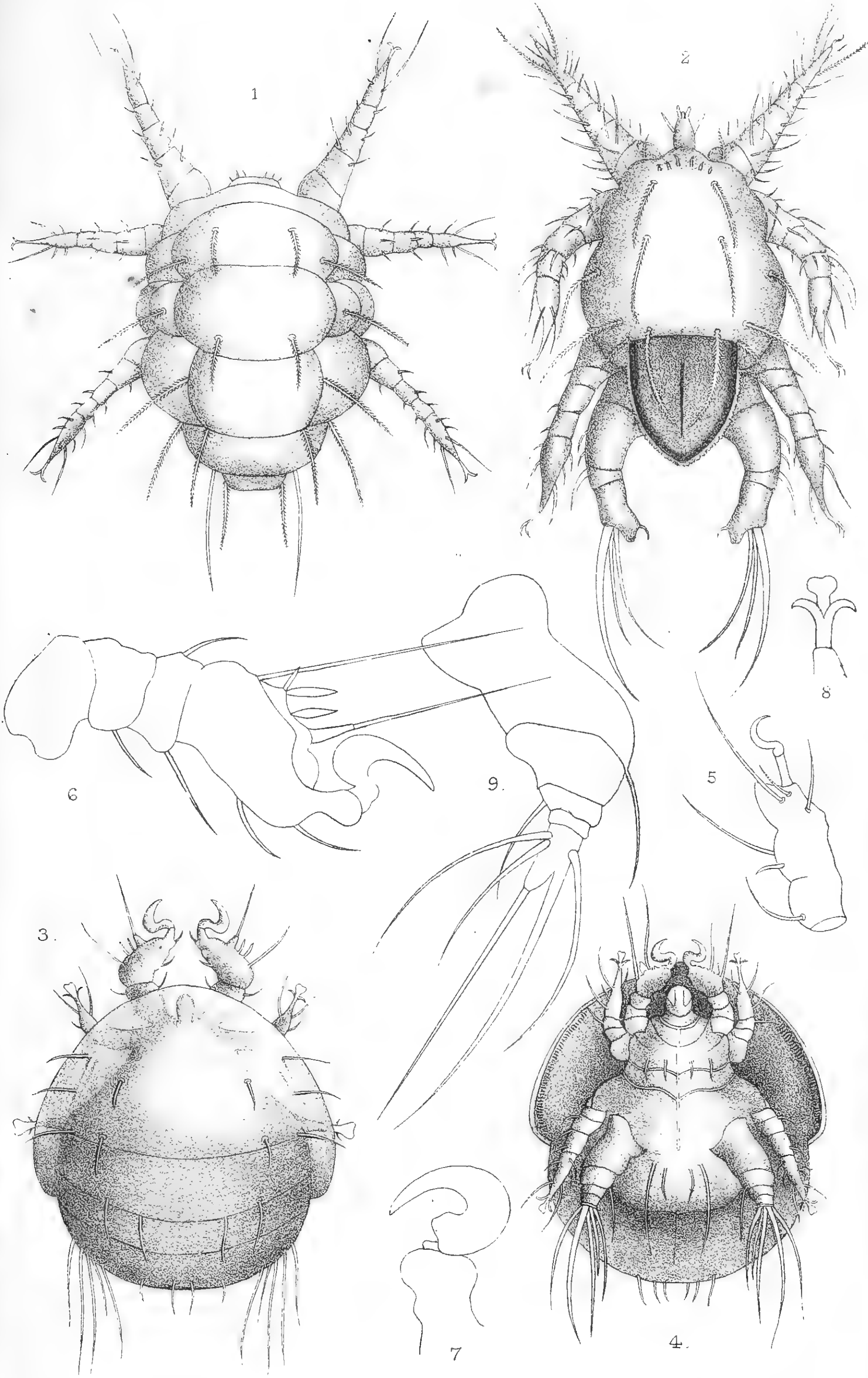

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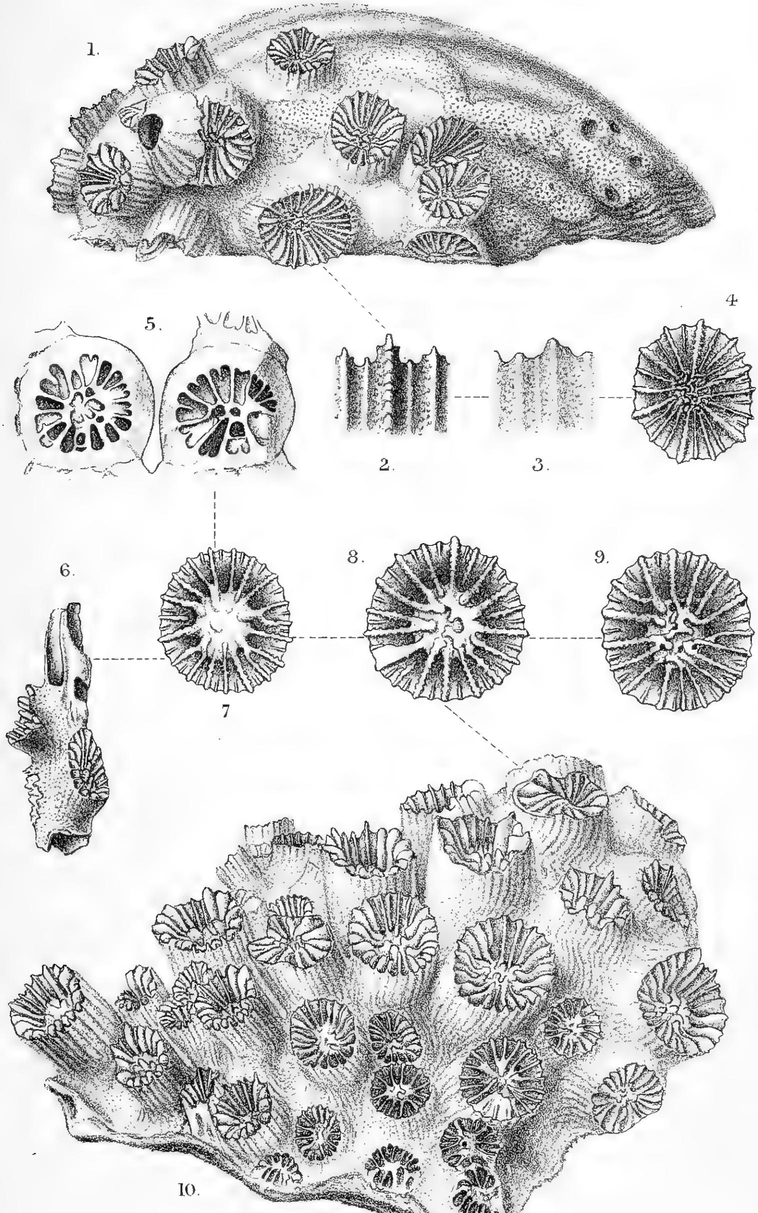

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1-4. PHYLLANGIA DISPERSA.
5-10. P. PAPUENSIS.

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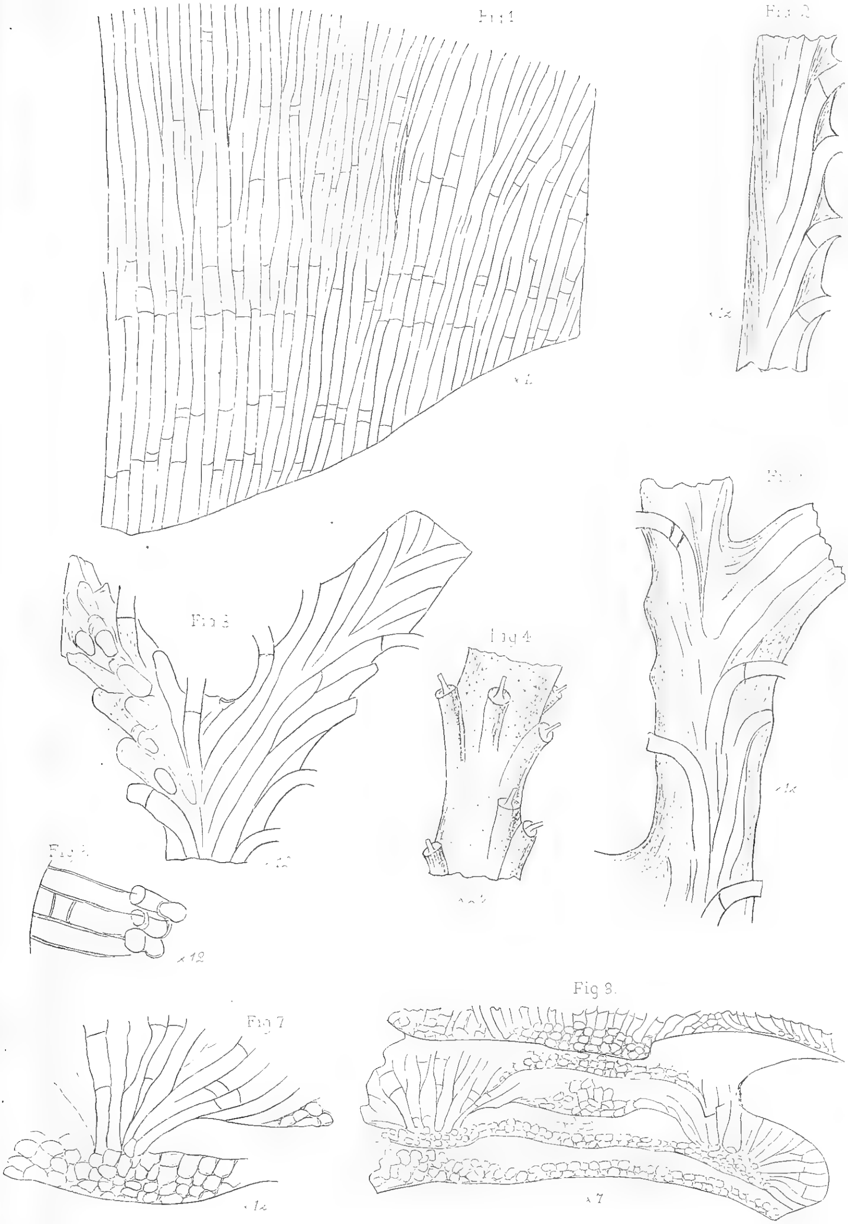

Berjeau sc

CLOSURE OF ZOOECIAL TUBE
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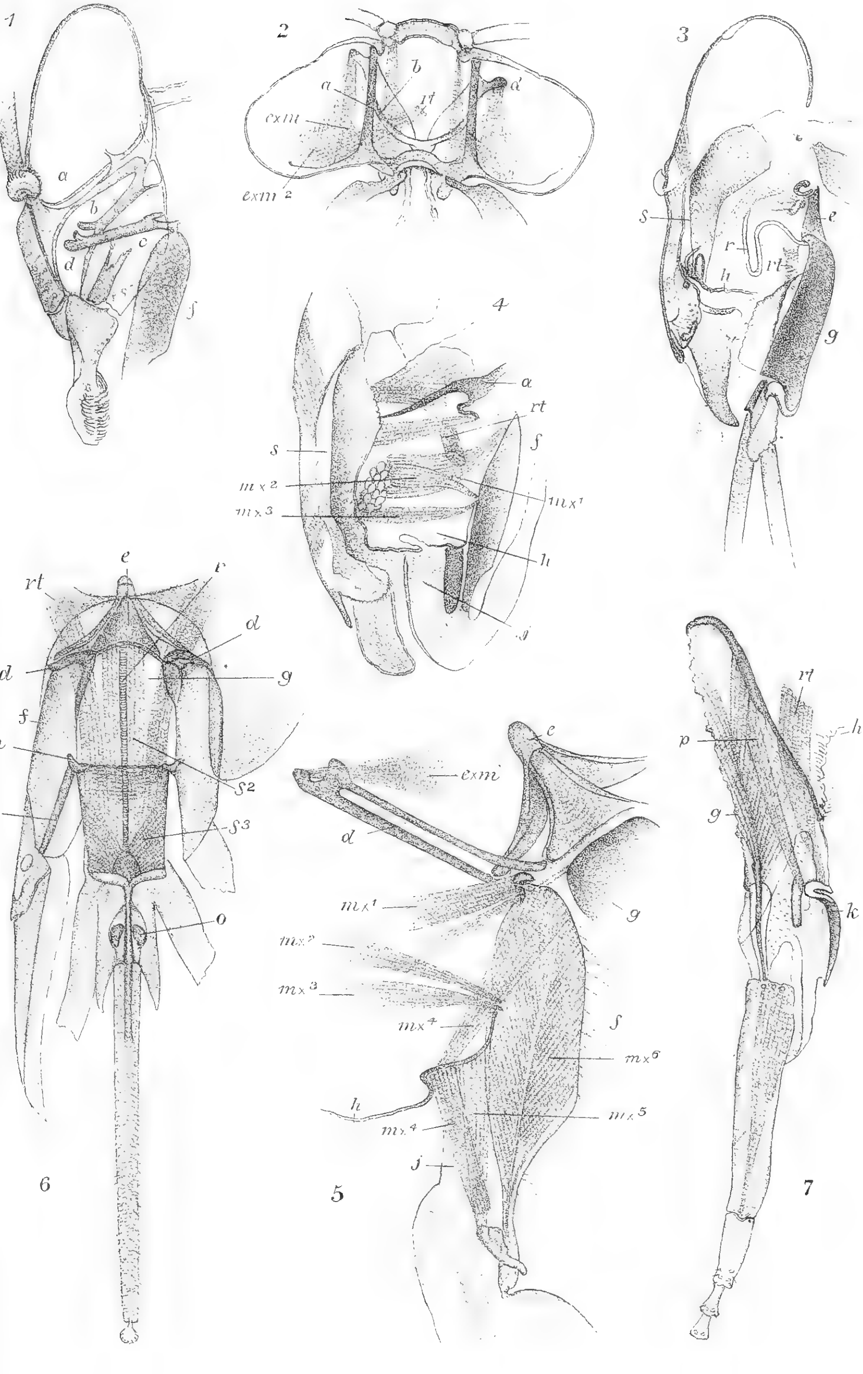

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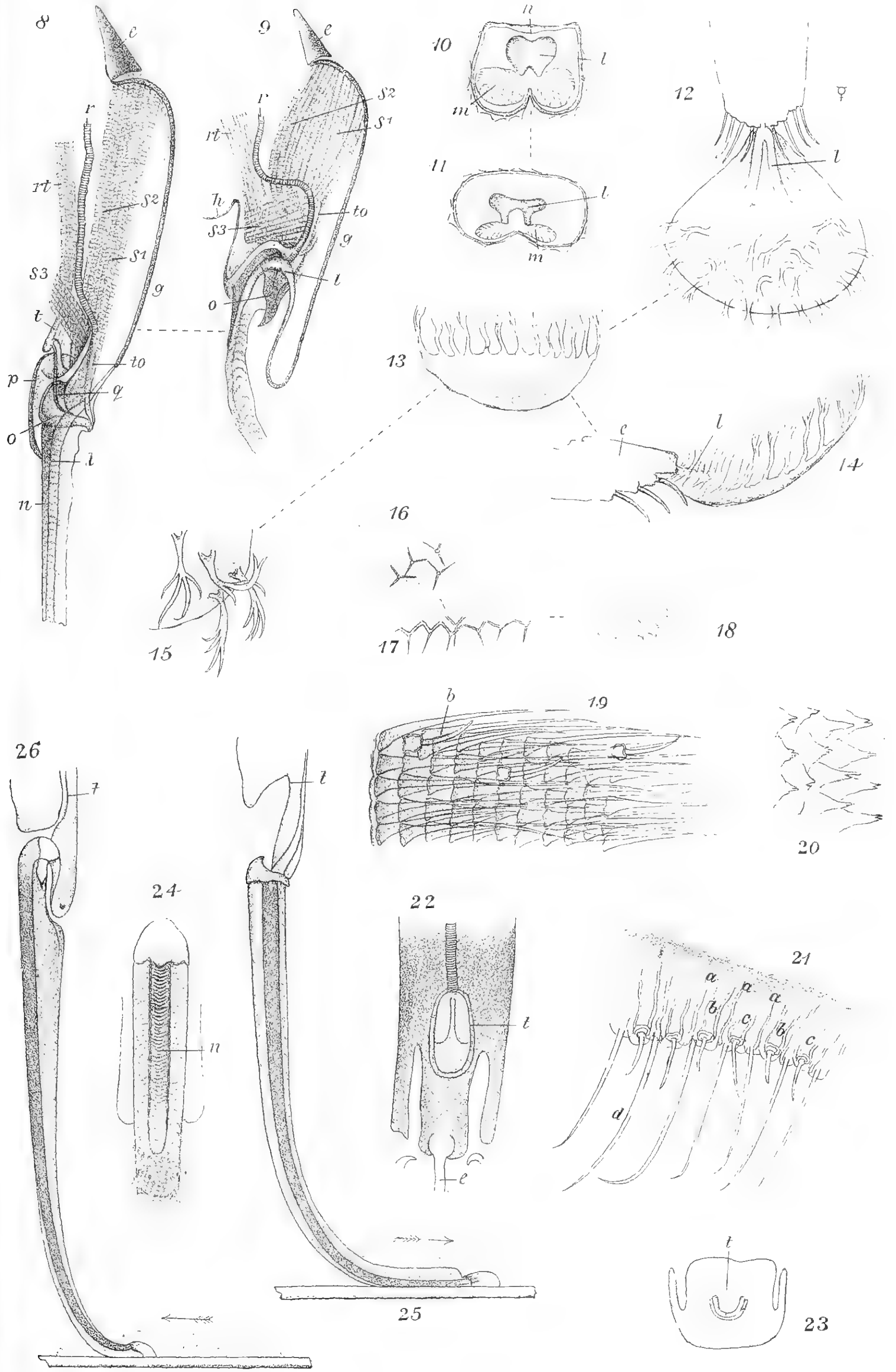
ANATOMY OF TONGUE OF HONEY BEE.



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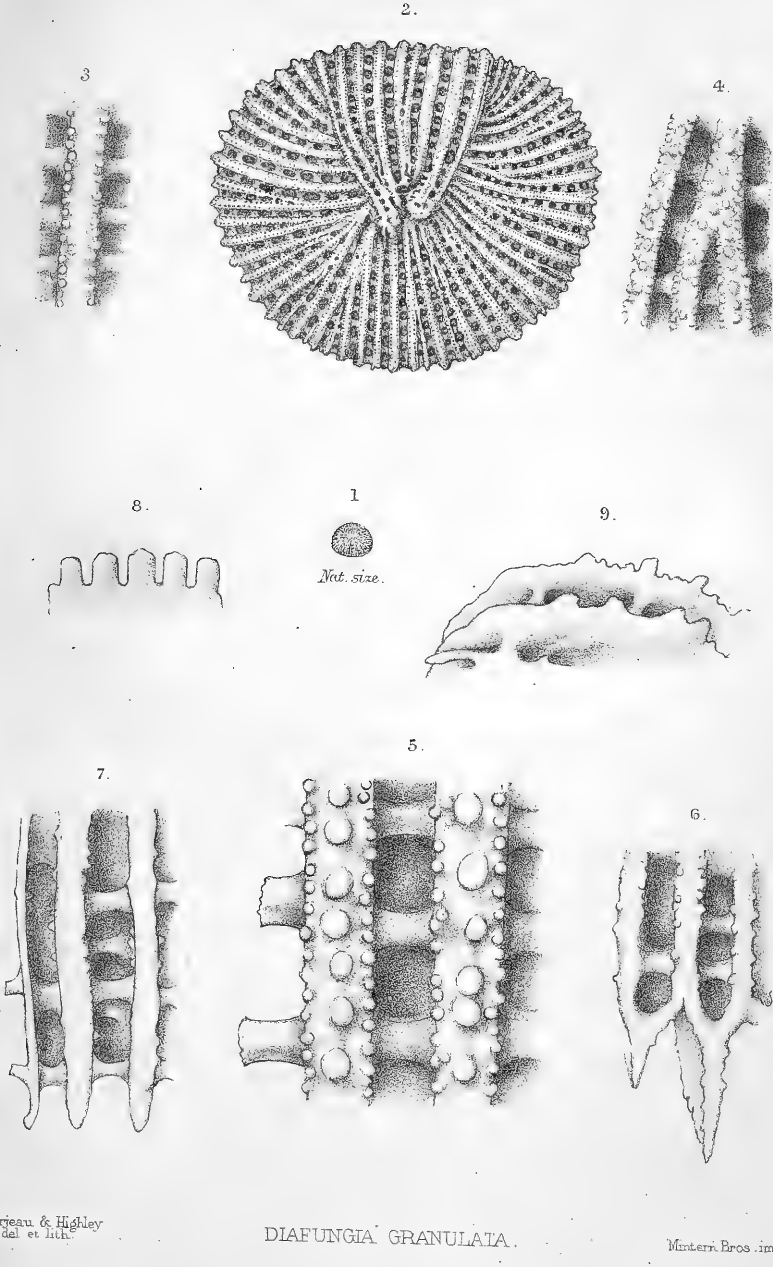

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